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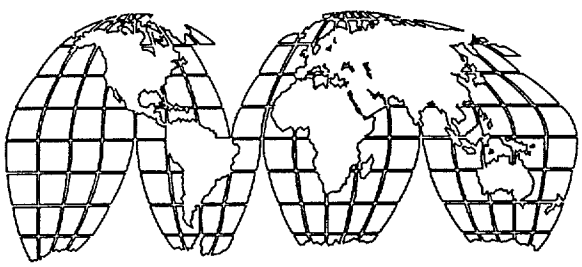

Sustainable Agriculture and the Environment:
Mali Case Study

March 1994

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Sustainable Agriculture and the Environment
MALI CASE STUDY

by

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This Working Paper is one of a number of case studies prepared for CDIE's assessment of USAID Sustainable Agriculture and the Environment programs. As an interim report, it provides the data from which the assessment synthesis is drawn. Working Papers are not formally published and distributed, but interested readers can obtain a copy from the DISC.

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PREFACE

A.I.D. development assistance has supported a broad spectrum of environmental and natural resources programs worldwide. The goals of these programs are environmentally sustainable economic development and an enhanced natural resource base on which it depends.

Mali is one of the countries where A.I.D. has provided support for two important areas of environment and natural resources management: sustainable crop land cultivation and forestry development. This report summarizes findings from an examination of Mali's efforts at promoting sustainable cropland management. It is one of six studies comprising CDIE's evaluation of the environmental impact of sustainable agriculture programs.

Over the thirty-year span of its assistance programs in Mali, A.I.D. has supported a range of development initiatives with environmental benefits. A.I.D. programs with direct environmental and natural resources management objectives are only of relatively recent vintage in Mali which, itself, has only had an official environmental program since the mid-1980's. This study focuses on the period from 1983 to 1992.

A CDIE team of evaluators visited Mali in August 1993 to gather information on which this evaluation is based. The evaluation team traveled extensively throughout the project zone interviewing farmer and rural household participants in the program as well as government and donor agency representatives assisting in building local and national capacity to conduct sustainable agriculture activities.

CDIE wishes to thank the staff of USAID Mission to Mali for its support in conducting the field study work. CDIE also extends its thanks and appreciation to the scores of Malian technicians who contributed to this effort.

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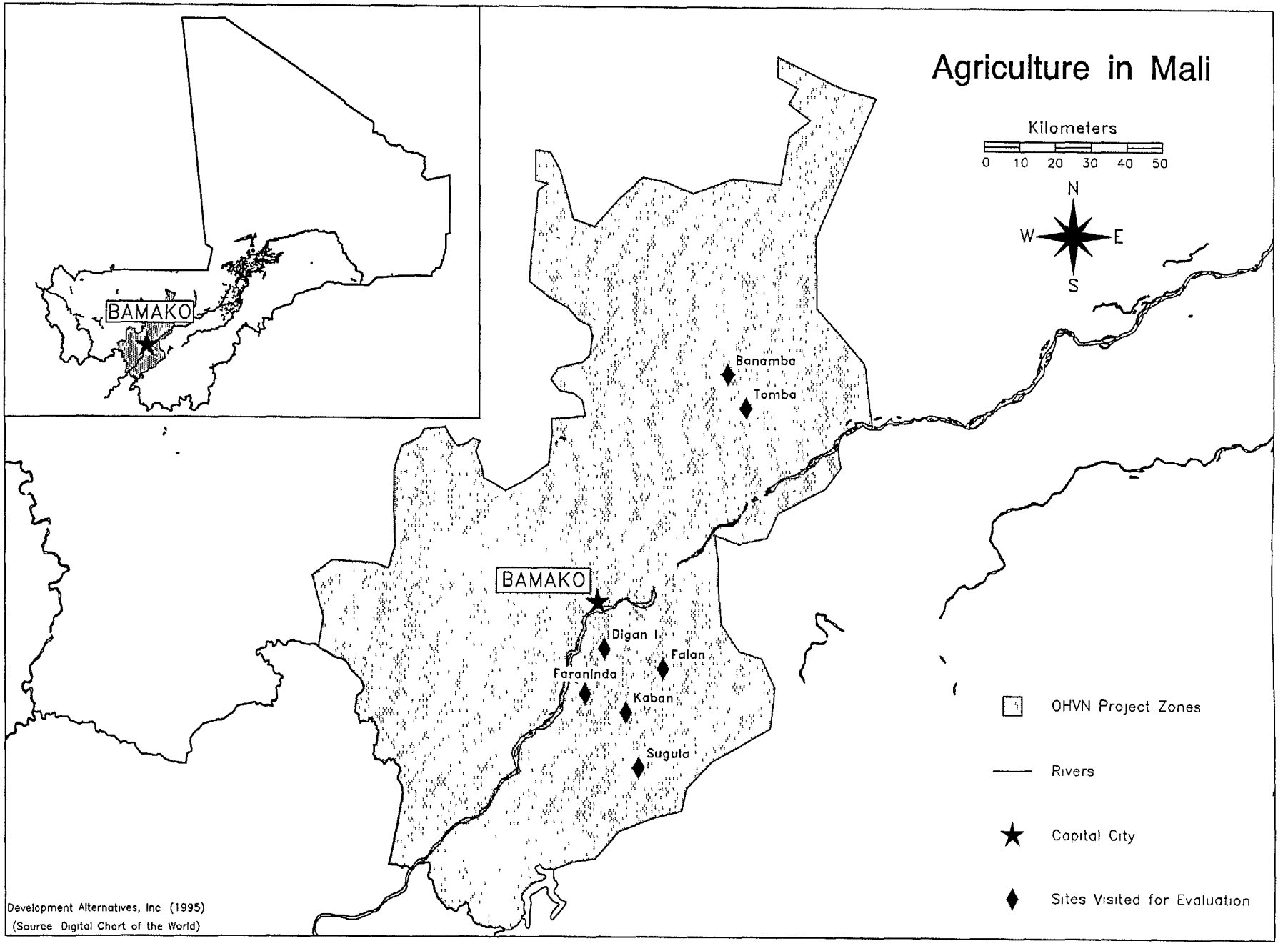
GLOSSARY

A.I.D.	United States Agency for International Development
APAP	Agricultural Policy Analysis Project (of AID/DC)
APEX	Animal Productivity and Export Project
BDM	Banque du Développement du Mali
BIAO	Banque Internationale pour l'Afrique Occidentale
BNDA	Banque Nationale du Développement Agricole
CIDA	Canadian International Development Agency
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CMDT	Compagnie Malienne pour le Développement des Textiles
COMADIS	Compagnie Africaine de Distribution
CRZ	Centre de Recherches Zootechniques
DED	Deutsche Entwicklungs Dienst
DHV	Developpement Haute Vallée (the second A.I.D. project)
DNAFLA	Direction Nationale de l'Alphabétisation Fonctionnelle et de la Linguistique Appliquée
DRSPR	Division de Recherche sur les Systèmes de Production Rurale
FCFA	French West African currency with fixed parity (50 FCFA = 1 French Franc)
FSR&E	Farming Systems Research and Extension
GRM	Government of the Republic of Mali
IARC	International Agricultural Research Center
ICRISAT	International Crop Research Center for the Semi-arid Tropics
IER	Institut d'Economie Rurale
IITA	International Institute of Tropical Agriculture
ILCA	International Livestock Center for Africa
IMF	International Monetary Fund
INRZFH	Institut National de la Recherche Zootechnique, Forestiere et Hydrobiologique
IRAT	Institut de Recherche d'Agronomie Tropicale
IRR	Internal Rate of Return
ISNAR	International Service for National Agricultural Research
KfW	Kreditanstalt fur Weideraufbau (Germany)
NCBA/CLUSA	National Cooperative Business Association/Cooperative League of the USA
NRM	Natural Resource Management
OACV	Opération de Arachide et Cultures Vivriers
OHV	Opération Haute Vallée (the first A.I.D. project)
OHVN	Opération de la Haute Vallée du Niger
OPAM	Office des Produits Agricoles du Mali
PACD	Project Assistance Completion Date
PAE	Projets de Agro-ecologie
PIRT	Projet d'Inventaire des Ressources Terrestres
PLAE	Projet Lutte Anti-Erosive
R&D	Research & Development
RDO	Rural Development Operation
SAFGRAD	Semi-Arid Food Grain Research and Development Project
SCAER	Société de Crédit Agricole et d'Equipement Rural
SECID	Southeast Consortium for International Development
SEMECMA	Societe d'Equipement Mechanique et de Machinisme Agricole

SMS	Subject Matter Specialist
SONANTAM	Société Nationale de Tabac et Allumettes du Mali
SPARC	Strenthening Research Planning and Research on Commodities Project
UNESCO	United Nations Education and Science Organization
ZAF	Zone de Alphabétisation


Agriculture in Mali
Kilometers
0 10 20 30 40 50
N
W
E
S
BAMAKO
Banamba
Tomba
BAMAKO
Digan I
Falan
Faraninda
Kaban
Sugula
OHVN Project Zones
Rivers
Capital City
Sites Visited for Evaluation
Development Alternatives, Inc (1995)
(Source Digital Chart of the World)

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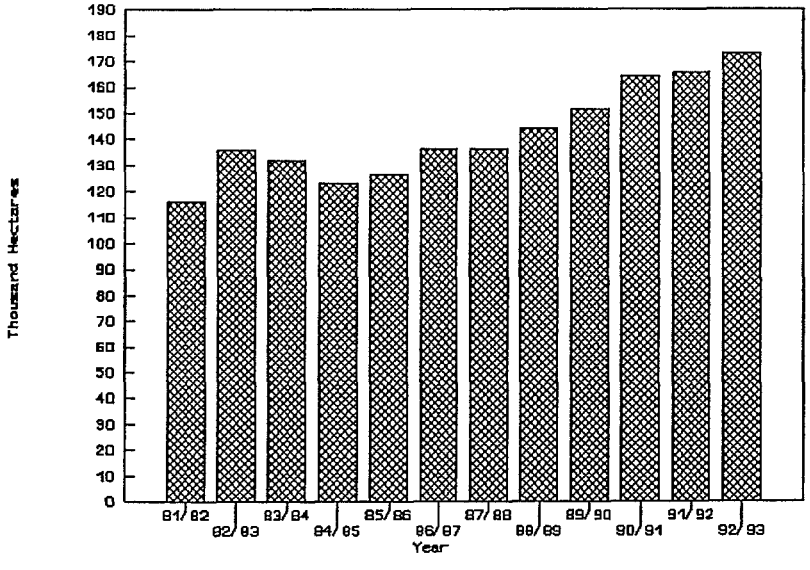
1. INTRODUCTION

Problem Statement

The purpose of this study is to review the development impact of A.I.D. interventions in sustainable cropland management in Mali. Sustainable cropland management is defined as "the introduction of crop cultivation systems aimed at stabilizing fragile soils and restoring and maintaining their productive capacity."[1] The operating hypothesis of the assessment is that adoption of environmentally sound cropland management practices result from A.I.D. agricultural programs that: strengthen capacities of national and local organizations in the planning, coordination, and implementation of agriculture-related activities; conduct education and outreach programs that raise awareness, transfer information, and promote empowerment; transfer or develop sustainable agricultural production technologies; and reform policies to remove input, product and land market distortions and other disincentives.

Like many developing countries, Mali has found that existing farming practices are inadequate to deal with increased pressure on available cropland. This is especially true in the Upper Niger River Basin region where non-sustainable agricultural practices (notably in cotton-based production systems), changes in rainfall patterns, deforestation, and population pressures seriously threaten soil fertility. The study focusses most of its attention on this region, as this is the part of the country where A.I.D. has the longest involvement in agricultural research and rural development. Soil fertility in Southern Mali's Upper Niger River Basin region is seriously threatened by non-sustainable cotton cultivation practices, population pressure, deforestation, and reduced rainfall levels. As Figure 1-1 shows, total planted area increased by nearly 50 percent between 1981/82 and 1992/93. This is partially due to the increasingly commercial nature of crop production (including cereals). Extensification has been accompanied by declining fallows on existing croplands. Traditional farming practices have proven insufficient to deal with increased pressure on existing cultivated land, as well as pressures on newly opened land, much of which is marginal. These

Figure 1-1
OHVN Zone Total Cropping Area, 1981/82 - 1992/93



[1] Quoted from: "Evaluation Design for A.I.D. Environmental Programs in the Agricultural Sector." CDIE, 1993.

disturbing forces had become evident to A.I.D. by the mid-1980s.

To combat the problem, A.I.D./Mali has provided $36 million in grants through two bilateral projects (plus additional funds via regional and international agricultural research projects) to support:

- Introduction of new technologies through: building extension capacity in both public institutions and among contract farmers; strengthening village-level organizational capabilities through financial management and functional literacy training;

- Development of environmentally-sound technologies appropriate to local farm conditions through farming systems research; and

- Improved linkages between national, regional, and international agricultural research institutions to build on the comparative strengths of each in developing new technologies.

Box 1-1 summarizes projects undertaken with A.I.D. assistance in the OHVN zone.

Box 1-1
A.I.D. Projects in the OHVN Zone

Operation Haute Vallee (688-0210) or **HVN I project:** This $19,995,000 integrated Rural Development Project started in 1978 and ended in 1988. Although it concentrated on food crop production, it financed road construction, animal traction training (including blacksmith training), research, credit for farmers to purchase work oxen and equipment, administrative support, rice polder rehabilitation, health services, and functional literacy. Credit for oxen and equipment (plows, seeders, harrows) was deemed sufficient to increase productivity of staple cereals (sorghum, millet, maize) and enable farmers to cultivate twice the land that they could using hand tools. Malian parastatals provided other credit needs.

Development of Haute Vallee (688-0233) or **HVN II project.** To confront chronic weaknesses of national agricultural institutions in delivering agricultural inputs and services in the HVN zone, AID and the Malian government in 1988 signed a new $17.5 million project to undertake local community development and institutional restructuring of the Operation HVN parastatal and provide further support to earlier Operation HVN project rural roads and functional literacy programs. The project included assistance from the National Cooperative Business Association to strengthen the cooperatives' capacities to absorb many of the parastatal's functions. This project was being amended at the time of the CDIE evaluation to extend it to 1998.

Farming Systems Research and Extension (688-0232) **(FSRE).** To address problems of stagnating crop production, USAID in 1985 authorized a 10 year $19.0 million Farming Systems Research and Extension (FSRE) Project to develop and introduce more sustainable production systems. The FSRE project provided support for on-farm development and testing of new sustainable agricultural practices and for extending these practices to farmers through better communications. A second phase project to strengthen agricultural research institutions and sustainable agriculture programs was authorized in FY 1992.

Conceptual Framework and Study Organization

To determine the cause and effect linkages between A.I.D. interventions and impacts, this study employs a framework that traces actions and events over a five-level continuum depicted in Figure 1-2. We begin with initiation of strategies and provision of inputs (Level I), proceed to program

outputs (Level II), to actual farm and village-level adoption of sustainable agricultural practices (Level III), to biophysical and socio-economic impacts (Levels IV and V). Technically speaking, only stages IV and V are considered as "impact" while earlier stages are considered as means to an end. It is recognized that impact is usually difficult to detect, either because technical problems of data availability render this problematic or because activities have not been taking place for a sufficiently long period of time to actually observe widespread impact. As will be discussed later in the paper, in the case of Mali, it is even highly problematic to determine the extent of adoption (Level III). Therefore, the CDIE assessment team spent most of its time addressing the question of whether developments at Levels I and II were "headed on the right track" to Levels III through V.

The organization of the assessment is structured around the five-level conceptual framework. The remainder of this first chapter is a brief description of the two most important public agencies intervening in the study zone which is the Upper Valley of the Niger River, in the vicinity of the Malian capital, Bamako. In addition, the farming systems of this zone are described. This is the biophysical foundation on which the bulk of A.I.D. interventions in sustainable agriculture in Mali rests. The next chapter discusses A.I.D. participation in and assistance to the development of national-level program strategies of relevance to sustainable agriculture. These are essentially interventions at Level I. Chapter III focusses on program outputs, especially A.I.D.'s contribution to the development of institutional capacities. The institutions and organizations covered are the national program for farming systems research, the *Opération de la Haute Vallée du Niger* (OHVN) extension agency, and village associations in the OHVN zone. Chapter IV provides an overview of sustainable agriculture technologies promoted through A.I.D.-supported projects and programs in Mali. The chapter also reviews the rather undependable data that currently exist on adoption rates. Most of Chapter IV is devoted to three case studies on promotion and adoption of sustainable agriculture technologies. These case studies demonstrate the complex interplay of institutional, organizational, and economic factors that encourage (or inhibit) technology adoption. The final chapter highlights issues related to the replicability, sustainability, efficiency, effectiveness, and impacts of A.I.D. sustainable agriculture interventions in Mali.

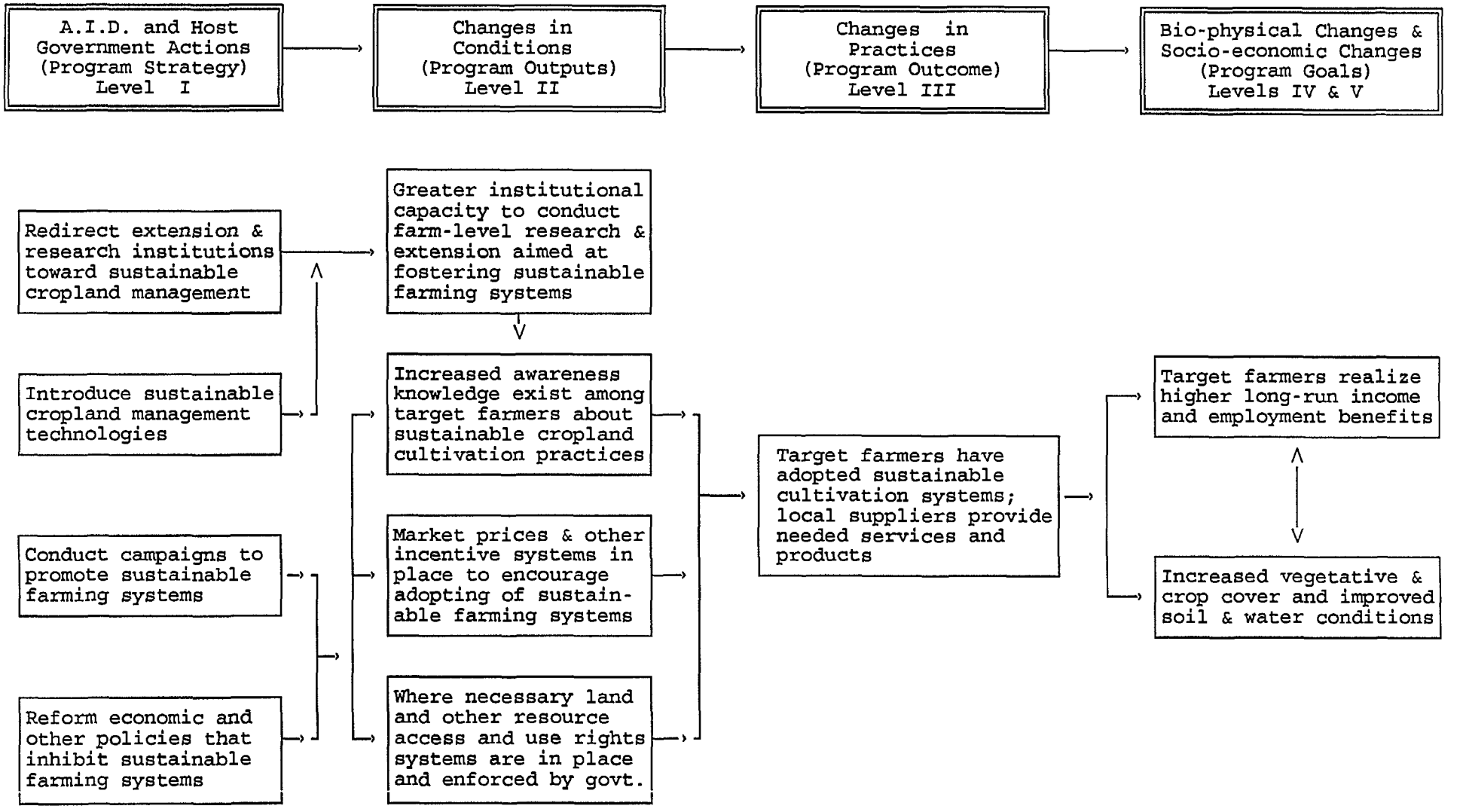
The Setting

Major Institutional Actors in Southern Mali Assisted by A.I.D.

The attached map shows the segment of Southern Mali where A.I.D. has been engaged in agricultural development since 1978. This has largely occurred through assistance to two GRM agencies: the *Opération Haute Vallée du Niger* (OHVN) and farming systems research implemented by the *Institut d'Economie Rurale* (IER).

The OHVN was established in 1972. Between 1974 and 1982, its zone of operation was repeatedly expanded, successively incorporating territory from adjacent Southern Mali agricultural parastatals, and finally the arid northern regions of Koulikoro and Banamba -- thereby tripling the total area of

Figure 1-2: Conceptual Framework for A.I.D. Cropland Management Programs



the OHVN and doubling its target population. A.I.D. has provided assistance to the OHVN through two projects, the first beginning in 1978, and the second in 1988.[2]

The IER was created in 1962 to conduct and coordinate agricultural research throughout the country. In 1985, A.I.D. authorized a ten-year Farming Systems Research and Extension project to provide technical assistance, training, equipment, and infrastructure to the division responsible for implementing farming systems research, the *Division de Recherche sur les Systèmes de Production* (DRSPR). A.I.D.'s support is in two regions, Mopti and the OHVN zone.

The Biophysical Foundation: Farming Systems in the OHVN Zone

The OHVN project zone is ecologically rather diverse, ranging from semi-arid northern zones in the north (less than 600 mm of rainfall annually) to high potential southern zones where rainfall commonly exceeds 1,500 mm. Bingen et al (1992) divide the OHVN zone into five "household economic portfolio groups:

Far North (Boron and northern section of Banamba). This zone is characterized by low (less than 600 mm) and highly variable rainfall. The most common cropping system involves short season local millet varieties inter-cropped with sorghum and beans (often for fodder as livestock raising is a major activity and there is an active fodder market in the zone). Principal cash crops are peanuts and Bambara groundnut (voaundzou). There is also emerging interest in sesame as a cash crop, although development of this crop is constrained by a lack of market outlets. The widespread practice of ridge cultivation means that most planting is done by hand[3] and there are typically two weedings for cereals each season. Spatially, farmers employ a system of inner fields fertilized with manure and other household waste, and outer fields whose fertility is largely maintained through fallowing. Ridge cultivation and rock barriers are traditional anti-erosion practices, acacia albida (locally known as *balanzan*) is used for soil management. "Agro-forestry parkland" also includes karité, tamarind, baobab, néré, duguru, and desert dates.

Near North (northern Koulikoro and southern section of Banamba). Rainfall in this zone ranges from 600-800 mm, and there are more cropping options than in the north. Millet and sorghum are the principal food crops cultivated, but fonio is also farmed, not only for home-consumption, but also for sales. Fonio has the advantage of having relatively high yields on poor soils. Vegetables are also cultivated, and cassava serves as an insurance crop. Out-migration to nearby Bamako is common in the dry season.

Bamako Central. Rainfall in this zone varies around 800-1,000 mm and tends to be less variable than in the northern zones. Due to proximity with Bamako and the presence of good road infrastructure, there are also more farm and non-farm related economic opportunities. Along with

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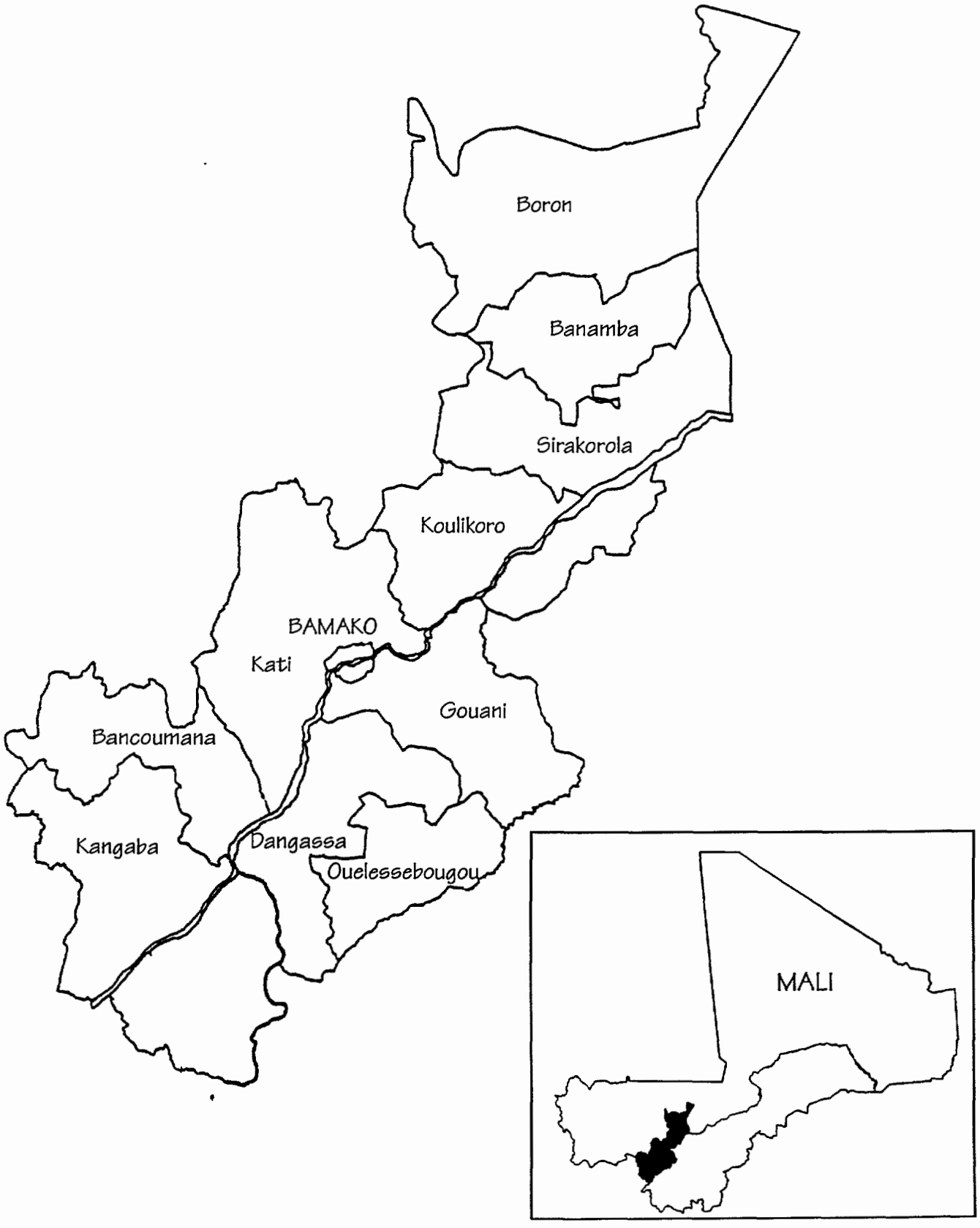
[2] Initially, the parastatal agency was called "OHV." In 1988, this was changed to "OHVN." The first A.I.D. project was called the "OHV" project, while the second one was termed the "DHV" project. For simplicity's sake, the parastatal and its geographic zone of intervention are referred to as "OHVN" throughout this report. The first and second projects are referred to as "OHV" and "DHV," respectively.

[3] Currently available mechanical seeders can not be used on ridges.

THE OHVN PROJECT ZONE



major cereals crops, niche markets are present for fodder production and truck-gardening. The phenomenon of absentee landlords who are government functionaries based in Bamako is also common, and this serves to aggravate tensions around land tenure.

Southeast (Gouani, Ouellessebougou, and southern Dangassa). Cotton dominates cropping systems in this zone, but there is also a broad range of secondary crops. Declining soil fertility and increased weeds (related to cotton) dominate soil management concerns, and land pressure has restricted women's access to land. Off-farm income is less important than in more poorly endowed zones due to the continued viability of agriculture as a full-time occupation. Road infrastructure (mostly financed by A.I.D.) is very good and is a major contributor to agricultural viability.

Southwest (Bancoumana and Kangaba). Highly integrated agro-forestry systems (mango, citrus, banana inter-cropped with as many as 15 cereals and vegetable crops) characterize this high potential zone. Yet declining rainfall is the main problem cited by farmers and the primary reason for increased attention to water retention technologies. Rice is the most important crop cultivated by women, and karité processing is the principal source of cash income for many women. Traditional natural resource management practices include construction of polders (first introduced during the colonial era). Improved low areas (*bas fonds*) also exist with wire mesh and rock check-dams for upland and floating rice varieties. Management strategies also consist of rotation of local varieties. This is very important for combatting weed pressure on rice fields.

2. A.I.D. INTERVENTION STRATEGIES AND CREATION OF CONDITIONS: POLICY FOUNDATIONS

Market and Price Policies

In a sense, Mali is unique among African countries in that much of what constitutes "agricultural policy" is not really decided at the national level. Most public intervention in the agricultural sector has historically been implemented through RDOs established to promote one or two crops in their particular zone of intervention. While many RDOs have been abolished or consolidated in recent years, a number continue to dominate agriculture and rural development in their zones. The most notable remaining RDOs are: *Compagnie Malienne pour le Développement des Textiles* (CMDT), which promotes cotton production in Southern Mali; OHVN, which also promotes cotton (and to a lesser extent tobacco) in Southern Mali and in several sectors just north of Bamako; and the Office du Niger, which promotes irrigated rice production in the Niger Delta.

While it is fair to say that the general thrust of agricultural policy is decided at the national level (to streamline or expand government intervention, to liberalize or control markets, etc.), the details of policy towards input distribution, agricultural credit, the role of rural cooperatives, and output marketing are decided within these RDOs, in dialogue with major donors. For the CMDT zone, the lead donors are the World Bank and the French. The OHVN zone is dominated by A.I.D., while the Office du Niger receives contributions from the World Bank, France, the European Community, and the Netherlands.

Up until 1980, the GRM tried to impose national credit and input supply policies through a parastatal, *La Société de Crédit Agricole et d'Equipement Rural* (SCAER). SCAER was granted an official monopoly on providing agricultural credit (with funds provided through the *Banque de Dévelloppement du Mali* (BDM) and distributing farm inputs and implements to farmers. Imported and locally-manufactured farm tools were provided through another parastatal, *La Société Malienne d'Etudes et de Construction de Matériel Agricole* (SMECMA). However, for several reasons (low repayment rates for credit, unsustainable subsidies for inputs, and internal inefficiencies that made SCAER an unreliable and untimely input and credit supplier), SCAER went bankrupt in 1980. To fill the vacuum left by the disappearance of SCAER, in 1981 the GRM created the *Banque Nationale de Développement Agricole* (BNDA). However, as mentioned above, the RDOs and their major donors have largely been granted autonomy to decide credit and input supply procedures and policies (Dione, 1989).

Cereals policy (other than rice policy which is discussed within the purview of the Office du Niger) is perhaps the one area where policy is truly "national." A.I.D. was in the forefront of donors that initiated dialogue in 1981 on cereals market reform. Prior to liberalization, the GRM through its cereals marketing parastatal (the *Office des Produits Agricoles du Mali* - OPAM) attempted to control millet, sorghum, maize and rice prices and act as a monopsony buyer from farmers, and act as sole importer/exporter of cereals. While OPAM's success in controlling prices and barring access to markets was limited, OPAM introduced a great deal of uncertainty and inefficiency into cereals marketing channels.

Through its Cereals Marketing Restructuring Project, A.I.D. has supported numerous market reform

measures. Under Phase I (1981-87) a number of reforms were initiated, including the following: OPAM operations were streamlined; import restrictions were eased for millet, sorghum, and maize; private traders were allowed to purchase cereals from farmers, breaking the OPAM monopsony; official producer prices were raised for all these commodities, and then completely liberalized for all except rice.[1] Phases II and III activities (1988 to the present) have concentrated on continuing rice policy reform, and assisting OPAM to effectively meet its new objectives of facilitating private trade through provision of price information and trader credit, and maintenance of a food security stock.

This has been a multi-donor effort, but it is important to note that from the beginning, A.I.D. was a major (and perhaps the dominant) player, supplying both financial and intellectual support (through studies and establishment of the market information system implemented under the centrally-funded Michigan State University Food Security Project, APAP, and other contracting mechanisms, and Mission in-house expertise).

What have these national-level agricultural policy developments meant for sustainable agriculture in Mali? Lifting the official state monopoly on credit and input distribution has increased incentives for farmers to seek out their own sources of finance and inputs. This of course assumes that policy set by the relevant RDOs also is conducive to free entry of input merchants and direct access of farmer organizations to banking institutions. Given the problems encountered by SCAER (similar to those of nearly every other agricultural credit and input supply parastatal in Sub-Saharan Africa), it is fair to conclude that this is the only sustainable policy course for Mali. Second, the disappearance of SCAER also led to reductions in fertilizer subsidies to farmers. Higher fertilizer prices (in combination with lower crop prices in recent years) have increased farm-level incentives to increase applications of organic fertilizers to maintain soil fertility. From a biophysical perspective, this is ultimately more sustainable than over-dependence on chemical fertilizers.

Regarding cereals market liberalization, the most important effect may be psychological, and therefore rather intangible. The fact that farmers and traders were given the opportunity to take on more decision-making themselves served to prepare them to take decisions in other areas more closely related to natural resource management than grain marketing. Also, the market liberalization of the early and mid-1980s was the beginning of chipping away at the coercive power of government agents vis à vis farmers and traders. Nowadays, extension agents must be more able to persuade people that new technical practices are a good idea rather than to coerce them.

In addition, cereals market liberalization was the precursor of much of the RDO down-sizing that began in the latter part of the 1980s. The streamlining of OHVN operations that began under the DHV project in 1988 was in many ways a logical extension of the streamlining of OPAM operations, and removal from the state of functions that more properly belonged with the private sector.

One (somewhat) negative effect of market liberalization concerns price supports. As will be seen in Chapter 4, price supports to maize and the presence of a guaranteed official sales outlet greatly stimulated adoption of improved streak-resistant varieties in the early 1980s in the CMDT zone. When price supports were removed in the mid-1980s, demand for improved varieties fell. However, demand picked up soon thereafter. Yet one can speculate that if price supports had not been in effect in the initial years during which these varieties were being introduced whether adoption would have

[1] For a chronology of reforms undertaken, see Camara (1990)

been so widespread.

Institutional Policy

Along with cereals market reform, A.I.D. has supported major institutional reform initiatives at both the sectoral and macro levels. At the sectoral level, A.I.D. has been involved in lending expertise to the reorganization of agricultural research policy. Direct involvement in this area is rather recent with initiation of the SPARC project in 1992. However, as a major donor in the areas of farming systems, research, and crop and livestock research, A.I.D. has closely followed and actively participated in GRM/ISNAR initiatives in national research policy planning and restructuring of IER since the late 1980s.

A.I.D. has been involved in macro-level policy dialogue since 1985, beginning with the Economic Reform Program, which provided budget support and technical assistance to the GRM. Policy areas where conditionality measures were initiated or where A.I.D. assisted the GRM include: removal of price controls; fiscal policy reform; drafting of a new commercial code; liberalization of import and export controls; and public sector restructuring through implementation of a voluntary early departure program for civil servants and improving fiscal administration. These efforts have been undertaken in close collaboration with the GRM, World Bank, IMF and other donors.

Once again, it is this last area that is of relevance to restructuring of major agricultural sector institutions. Macro-level restructuring provided the overall framework for restructuring efforts of IER and the RDOs. It is unrealistic to think that OHVN streamlining could have taken place in isolation of these more general trends at the macro level. OHVN reform has taken place concurrently with reform of CMDT, the Office du Niger, and OPAM.

Land Tenure Policies[2]

Land tenure policy in the francophone countries of the Sahel concentrated power over natural resources in the hands of the State, and a corresponding lack of local participation in local resource management. Mali is no exception to this rule (McLain, 1992). Rights to land are also governed by customary law at the village or pastoral level. The Government recognizes customary tenure at the village level, although it also claims ownership over all unregistered land in the country, or virtually all land outside urban centers (Koenig, 1993). Few families or individuals rural areas have formalized their claims using the registration processes set forth in Mali's Code Domanial et Foncier. Rural residents tend to follow customary practices regarding ownership and usage rights, and only use state procedures in extreme circumstances. (McLain, ibid, 5).

Traditional tenure is collective in the sense that boundaries are generally recognized between different villages, but not officially demarcated between individual families. Cultivated fields, pasture lands and used bush areas are included within the village domain, but Malian land law does not give official status to pasture and bush areas. Individual families are usually recognized as proprietors of certain areas that their family has cultivated for a long time. In the OHVN zone, the situation is complicated by "weekend farmers" from Bamako who have obtained rights to use (often prime) land due to their

[2] Much of this information comes from Dolores Koenig's draft paper on Pests and Pesticide management, dated June 7 It should not be quoted as the source until after AFR/ARTS/FARA has cleared it

clout and who have negotiated an agreement with the local village chief to use the land. They must farm the land for five years before they can formalize their title through registration.

The Malian State's claim to tree resources rests primarily upon the Forest Code of 1935, as revised in 1986. It distinguishes between forest and non-forest domain. The non-forest domain consists of land in fallow for less than five years, non-wooded land for which a land title in the name of a non-state entity has been obtained and developed (urban) areas. A forest domain includes forests, areas reforested by communities and individuals and registered in their names, sacred forests, land excluded from clearing actions (river banks, dunes, slopes, watering points and spring basins), wooded animal passages, and cropped land in fallow for more than five years.

The Forestry Code restricts the customary rights that landowners have to prune and cut down trees. It has a number of serious ambiguities. It does not state whether the use rights principle applies to trees located on unregistered land outside the forest domain and fails to define the rights of individuals and communities to forest resources in the non-forest domain.

Farmers interviewed in the southern portion of the OHVN zone indicated that they clearly believed that they had the right to make use of tree products on their own fields, including fruit, bark, trimming, and even cutting down of trees that they had planted. Visual evidence of this was clearly apparent. Even in a non-project village close to the project zone, local women were selling wood that they had gathered. Views were not expressed that indicated a fear that the farmers would be fined for managing trees on their fields. Given the fact that trees and wood are much more plentiful in the high rainfall (and relatively light) population density of the area concerned and its long involvement in rural development projects, this finding is not particularly surprising. However, some concern existed about shortage of land for new fields, which may be related to the permits and fees for clearing land discussed above. (Fessenden July 12 field visit).

3. A.I.D. INTERVENTION STRATEGIES AND CREATION OF CONDITIONS FOR ADOPTION: INSTITUTIONAL CAPACITIES

This chapter focusses on program outputs, especially A.I.D.'s contribution to the development of institutional capacities necessary to develop and promote use of sustainable agricultural practices (Level II indicators). The institutions and organizations covered are the national program for farming systems research, the OHVN extension agency, and village associations in the OHVN zone. Among other things, it will be argued that the most fundamental change to have occurred in recent years concerns the development of viable village-level organizations that have the potential to manage sustainable agriculture activities.

It will be argued that numerous successes have been achieved. Successes are the result of a number of factors coming together, including: a strong functional literacy base; liberalized markets; a public commitment to democratization and local-level empowerment; access to high-quality training in financial management and organizational skills; and ready access to markets. Active involvement of the commercial banking sector is especially noteworthy. Although it is rare for commercial banks to show interest in extending credit to small farmers, they have taken on an active role in lending to small farmers at market interest rates. Their involvement is predicated on the following conditions: lending is to groups with "solidarity" as collateral; evidence exists of rudimentary financial management capabilities; and a reliable cash crop (cotton) is used as the basis for lending.

Yet this promising base for sustainable agricultural development is still fragile. Poor prospects for world cotton prices threaten the economic foundation of southern Mali. Failure so far to develop a viable plan for road maintenance in the OHVN zone remains a concern. GRM inability to meet the recurrent costs of IER, OHVN, and DNAFLA could seriously compromise generation of new sustainable agriculture technologies and continued dissemination of existing ones, as well as training the next generation of literate farmers. Related to this, is the intense pressure/overworking of the existing pool of village-level animateurs with minimal (or nonexistent) remuneration.

Research Institutions

Box 3-1 provides a chronology of major events in Malian post-independence agricultural research history. The GRM created the Rural Economy Institute (IER) in 1962 to conduct and coordinate agricultural research throughout the country. The institute was placed under the authority of the Ministry of Agriculture. Shortly thereafter, IER signed an agreement with the French Tropical Agricultural Research Institute (IRAT) to conduct research on rice, wheat, and maize varietal improvement, sugar cane, industrial crops, and soils. Involvement of the International Agricultural Research Centers (IARCs) in Mali began in the mid-1970s, with the International Crop Research Center for the Semi-arid Tropics (ICRISAT), the International Livestock Center for Africa (ILCA), and the International Institute of Tropical Agriculture (IITA) work on food crops and animal production systems. Since 1987, the International Service for National Agricultural Research (ISNAR) has been assisting the GRM on research policy and institutional reorganization.

Mali's experience with farming systems research (FSR) is relatively short. FSR began in the late 1970s, when an FSR team was installed in the research station at Sikasso and FSR was elevated to divisional status within IER -- la Division de Recherche sur les Systèmes de Production or DRSPR. In 1985, A.I.D. authorized a ten-year, $19 million Farming Systems Research and Extension

Box 3-1
Malian Agricultural Research Chronology

Year	Event
1962	IER created, and placed under responsibility of the Ministry of Agriculture
	TA agreement signed between GRM and IRAT to conduct research in the areas of soil science, rice, wheat and maize varietal improvement, industrial crops and sugar cane
1976	ICRISAT begins assisting IER with on-station trials on sorghum, pearl millet, and maize (support from A.I.D. through Ford Foundation)
	ILCA begins research on animal production and pastoral systems
1977	Farming Systems Research created as cell within Agronomic Research Division
1978	FSR team (with Dutch TA) begins work in Sikasso (CMDT zone)
1979	Farming Systems Research raised to division level with headquarters established in Sikasso
	AID-funded (partially) SAFGRAD project begins assisting IER with on-farm trials on sorghum, millet, cowpeas, and maize
1985	10 year, $19 million AID-funded Farming Systems Research and Extension project authorized
1986	Technical assistance team from SECID begins to arrive and first AID-supported FSR team established in Sotuba to conduct research in the OHV zone
1987	ISNAR assistance begins to GRM on how to increase IER capacity to carry out research
1989	First (Year 4) evaluation of FSR&E project conducted
	By this year, 19 long-term participants sent to US for MS and Ph.D training
1990	DRSPR division headquarters shifted to Sotuba (building constructed with FSR&E project funding)
	National Institute for Animal Science, Forestry and Water Resources Research (INRZFH) merged with IER
1991	Second AID-supported FSR team established in Mopti
1992	ISNAR-sponsored report completed on national agricultural research strategy, including IER reorganization
1993	Second (Year 7) evaluation of FSR&E project conducted

Source: AID/Mali.

(FSR&E) project to provide technical assistance, training, equipment, and infrastructure to the DRSPR. The project has three objectives:

- To expand FSR activities to two additional agricultural production zones: beginning in 1985, the Haute Vallee, to be served by a team working out of the Sotuba station (near Bamako) to work with OHV; and in 1991, the Mopti area, to serve several RDAs working in Region V;

- To improve linkages: among the varying disciplines within the national research system; between DRSPR and various national agricultural policy and planning agencies; between the national system and IARCs; and between research and extension in-country; and

- To provide staff development via both longterm overseas studies for advanced degreee and by shortterm and on-the-job training.

Specific project inputs were to include: 36 person years of longterm technical assistance in research management, financial management, data processing, socioeconomics, and agronomy; funding for a total of 19 Malian researchers to pursue MS and PhD degrees in the United States (13 and 6 respectively); construction of offices and housing at the Sotuba and Mopti stations; office and field supplies, equipment, and salaries for local personnel.

With regard to long-term technical assistance, the project paper laid out a scenario whereby a research manager (also serving as chief of party), financial manager, and a data-processing specialist would assist the head of the DRSPR to increase the division's capabilities in these areas.

Development of research capacity at the Sotuba station has been hampered by weaknesses in delivering sufficient and appropriate long-term technical assistance; frequent turnover at the chief of party level has especially hindered performance. In addition, there has been duplication of effort and poor coordination in research field trials, and only limited solicitation and use of farmer feedback in field trials. While there is a recognition that the FSR project is still relatively long, and that the types of changes implied by introducing an FSR approach take time, concern remains that DRSPR is not on the right track. This is at least partially due to the limited effectiveness of technical assistance to date.

OHVN Extension

As noted above, for nearly 20 years agricultural development and extension in most of Mali has been assigned to parastatal RDOs, each backed by technical and financial assistance from one or more bilateral or multilateral donors. As Box 3-2 indicates, the Operation Haute Vallee was first established as an RDO in 1972. Between 1974 and 1982, its zone of operation was repeatedly expanded, successively incorporating southerly OACV lands from Mali's groundnut RDO (the Operation de Arachide et Cultures Vivriers), then some of the more westerly parts of the CMDT cotton operation, and finally the arid northern regions of Koulikoro and Banamba -- thereby tripling the total area of the OHVN and doubling its target population.

Most of this territory was added after A.I.D.'s 1978 agreement to support the Operation in foodcrop production via the OHV Project. In accord with GRM agricultural policy at the time, A.I.D.'s project was configured as an integrated rural development initiative spanning seven major components: road construction, animal traction training (including blacksmith training) and research, credit for farmers to purchase work oxen and equipment, administrative support to OHV, rehabilitation of a large rice polder in the zone, health, and functional literacy.

To meet A.I.D.'s stated interest in foodcrops, credit for work oxen and equipment (plows, seeders, harrows, multicultivators) was deemed sufficient to increase the productivity of the staple cereals (sorghum, millet, maize) merely by the deep plowing that animal traction makes possible. This strategy was also expected to greatly increase total foodcrop production by leading smallholders to cultivate twice as much land (10 ha instead of only 5) as they could with handtools (after Ronco Consulting Corp. 1985:23-24). Animal traction was considered a "good bet" for largescale adoption in that this technology was already a familiar one within the zone. Supposedly all that was needed to extend it to smaller farm families was credit. Thus, A.I.D. financed a revolving fund solely for this purpose. Other agricultural credit needs, e.g. for chemical fertilizers, were to be supplied by SCAER.

Animal traction was used primarily to increase cotton area and production. As a 1985 economic analysis found, "the area increase (when ox-tracton is acquired) is greatest in the case of cotton and lowest in the case of staple cereal crops. This might be predicted since the purchase of ox-traction does not increase the food requirement of the family, but it does necessitate the generation of cash to repay loans and for the continued purchase of inputs" (King 1986:15).

In any case, foodcrops were not long a development priority for the OHVN (although they may have remained so for A.I.D.). With falling government groundnut prices, a weakening market in tobacco (a traditional Haute Vallee cash crop), the impending liberalization of the cereals market, constant A.I.D. pressure for OHVN to move toward greater financial autonomy, and the bankruptcy of

Box 3-2
Chronology of Haute Vallée Development

Year	Event
Early 70s	First OACV (the groundnut RDO) experiments with farmer marketing groups.
1972	Creation of Operation Haute Vallee (OHV) as a parastatal RDO (Dangassa, Kangaba, Siby areas).
mid-70s	CMDT begins to form farmer marketing co-ops.
1974	Presidential appeal for all RDOs to incorporate a functional literacy (FL) component.
1974/75	Former OACV area of Kati and SONANTAM (the national tobacco company) area of Baguineda added to OHV zone.
1975/76	First DNAFLA functional literacy centers opened in the zone, supported by OHV and CIDA.
1978	USAID five year project agreement signed with OHV for $18,395,000, with aim of increasing foodcrop production in the zone -- although at the time, tobacco was the major source of marketing revenues. $86,000 of this for DNAFLA FL program.
1978/79	CMDT area of Ouellessebougou added to OHV zone.
1979/80	More CMDT areas (Gwani, N'Kuraba) transferred to OHV.
1980	First internal evaluation of DNAFLA component of OHV Project. SCAER goes bankrupt.
1981/82	Addition of the northern (formerly OACV) regions of Koulikoro and Banamba to OHV zone, thereby tripling the total area of the zone and doubling its target population.
1981	Midterm evaluation.
1978-84	Repeated suspension of funds and various OHV activities due to non-certification of OHV financial and credit systems.
1982	Animal traction training and research component essentially abandoned; AID funding of FL component suspended. Evaluation study of OHV extension system. AID audit World Bank assessments of performance of all RDOs in Mali, leading to national policy debates on re-structuring. GRM decree in support of a national policy to promote *tons villageois* as the engine of rural social and economic development.
1983	AID support for FL component suspended. 8th project amendment signed, extending PACD to Feb 1985 and substantially re-designing project; health component and rice irrigation dropped; FL targets reduced by 50%; FSR/E component to be added through support to DRSPR; plans to do PIRT land-use studies; and overall emphasis on strengthening OHV administration and management, financial controls, credit operations, etc. First experiments between OHV and BNDA with group credit for village associations.
1984	Second internal DNAFLA evaluation. Contract signed between OHVN and DNAFLA for provision of AID-funded FL training in OHV zone until 1988, to be renewed annually. Final evluation of OHV (Ronco) -- at this point, 195 km of road completed.
1985	Project ammendment extending AID support to OHV until 1987/88.
1986	Design studies conducted in preparation for new, DHV Project. Subjects treated included privatization, farming systems, technology transfer,rural credit, and farmers' associations.
1986	AID policy discussions with Malian banks begin.
1987	EOP of OHV Project. SMECMA (government ag equipment company) goes out of business.
1988	ARARA (private ag equipment company) is formed. New GRM cooperative law passed. New 5 year DHV Project agreement signed with now-named OHVN (Operation Haute Vallee du Niger) for $17,500,000 ($3,600,000 for CLUSA activities), with primary purpose of ag extension and community development planning and 3 principal components (OHVN restructuring, rural enterprises and institutions, and rural roads.
1988	OHVN/DNAFLA contract signed for 4 more years of FL training.
1989	CLUSA begins field operations.
1991	Joint USAID/DNAFLA/OHVN evaluation of project's FL component.
1992	DNAFLA contract extended for one more year. Publication of *Schema Directeur du Secteur Developpement Rural.* Conference on *Etats Generaux du Monde Rural.* Reportedly 500+ FL centers functioning in zone.
1993	Amendment of DHV Project to add 4 more years, with a new component in agribusiness/export marketing; plus renewal of CLUSA and OHVN/DNAFLA contracts for 4 more years. At this point, a total of 559 km of road

SCAER in 1980, the Operation turned to cotton as its only hope for a significant source of revenues

and for a credit basis to increase this source. Cotton thus became the raison d'être of OHVN efforts to extend credit, technical information, and marketing services to producers within its zone. Among other things, this meant that the Operation paid little attention to its northern region, where inadequate rainfall makes cotton production impossible. In sum, "Because of the Operation's dire need to obtain credit funds for cash crop (i.e. cotton) farmers, the project's focus on food crops has been lost" (Ronco Consulting Corp. 1985:28).

However, as early as 1979 the OHVN credit program was floundering. A 1982 A.I.D. audit of the project found "an appallingly low repayment rate of 38 percent" (ibid.) In view of this and many other problems in the project -- notably, with overall OHVN accounting, inventory, and administrative procedures, and with the functional literacy component -- in 1983 the OHV Project was substantially redesigned and simplified.

Among other things, the redesign entailed reforms that largely ended credit for work oxen and in effect allowed input and equipment credit only to farmers who grew cotton or tobacco (Clark 1986:4). The new rules required OHVN base-level extension agents to verify the hectarage of cotton land seeded and germinated before a producer could obtain inputs (now including fertilizer) on credit. Input quantities were strictly limited to the amount corresponding to the hectarage planted. The extension agent forwarded his approval to his superiors; under the agent's guidance, OHVN employees then delivered the inputs (not cash) to the approved producers. After the cotton harvest, OHVN deducted the cost of the inputs from the borrowers' earnings before paying them for their crop. No credit was available for foodcrops, although it was argued that cereals would benefit from the residual fertilizer on cotton fields in the next year's rotation. Obviously, this only benefitted cotton farmers. Partly in order to find a way to service non-cotton growers' credit needs, circa 1983 the OHVN also began to experiment with strategies of bank credit extended directly to groups of farmers organized in village associations qua pre-cooperatives.

Much greater detail on the history, operations, and impacts of the OHV Project is offered by the series of five design studies conducted in 1986 in preparation for the follow-on Development of the Haute Vallee (DHV) Project. According to the 1986 study of technology transfer in the Haute Vallée, under the OHV Project the extension service was plagued by poor performance and had a minimal effect on increasing foodcrop production and productivity in the project zone. Weaknesses included:

- Low levels of technical competence and morale on the part of field agents due to poor pay and working conditions;
- Inadequate supervision and follow-up of agents; lack of systematic programming of extension activities;
- Failure to differentiate technical recommendations by agroecozone; and
- Preoccupation with non-extension tasks such as input delivery, data collection, and above all, credit management (Lebeau, 1986).

Indeed, OHVN agents were found to spend more than two-thirds of their time on these non-extension-related activities; and their role as "credit police" further jeopardized their credibility and effectiveness as agents of technological change.

The same study also concluded that there was a dearth of improved technologies to extend to farmers for foodcrop production. With the exception of maize varieties, no significant breakthroughs had been registered in grain and legume varietal improvement as of the mid-1980s. This fact is especially important in that an extension agency's credibility with its clients is often first established by offering one or two improved varieties that are clearly superior to existing ones. In contrast, offering only improved cultural practices rarely results in ready client confidence in extension or in quick and widespread adoption.

Overshadowing all these extension problems was OHVN's dependence on cotton for the bulk of its operating expenses. Even if some "revolutionary" new technologies had been available for sustainable foodcrop production and croplands management, it is questionable how much institutional incentive there would have been for OHVN to extend them. The same question arises today with regard to NRM technologies and practices. So long as the institution's financial survival remains tied to cotton, its interest in widespread dissemination of NRM strategies may be largely limited to their benefits for cotton. As before, benefits to foodcrops may be epiphenomenal. Of course, this makes them none-the-less real, since cotton and foodcrops are rotated on the land annually. But also as before, the question remains: what about the non-cotton producing farmers and regions of the Haute Vallée?

One of the major goals of the 1988 DHV Project was to assist the OHVN restructuring effort so that it focussed primarily on its extension mandate. In brief, the DHV Project sought "...the transfer of responsibility for the management of agricultural credit and input/output marketing from the OHVN...to village associations or pre-cooperatives, private enterprises and banking institutions. The primary purpose of OHVN will become agricultural extension and community development planning" (A.I.D./Mali 1988: DHV PP). Building on the World Bank's training and visit system of agricultural extension, the restructured OHVN and its supporting DHV Project identified the following measures to increase extension effectiveness in the zone:

- A 50% reduction in OHVN staff, made possible by, among other things, redefining the roles of OHVN extensionists to focus exclusively on extension. In the long run, field responsibility for management of credit, marketing, and input supply was to be shifted to local village associations or village associations;

- An increase in the number of OHVN extension sectors from 6 to 10 and replacement of the previous four-tiered system (headquarters, sector, subsector, and base-level) with a three-tiered structure that omits the base-level agents. The goal here was, again, to reduce OHVN staff while also facilitating communications up and down the chain of command;

- The transfer of a number of base-level extension responsibilities to village *animateurs* or farmer-agents of village associations;

- Improved technical support to extension through the creation of seven Subject Matter Specialist (SMS) positions at headquarters, for better liaison with research to ensure that new technologies and practices are communicated to field-level extensionists;

- Clarification of extension messages through the systematic production and distribution to agents of *fiches techniques* or "technical sheets," and follow up with bi-weekly planning

meetings between sector and subsector chiefs to make sure that messages get out and that farmer feedback percolates up through the OHVN hierarchy; and

- A shift from individual to mass and/or indirect methods of extension communication such as farmer field days, farmer-to-farmer visits, pilot farmers, village extension groups and their designated contact farmer.

With the exception of the 50% staff reduction, all other measures have been implemented.[6] Among the most notable is the transition from OHVN-managed credit to a system wherein village associations deal directly with banks for short and medium-term agricultural credit,[7] as well as credit for village-

Box 3-3
Commercial Banks and Agricultural Credit in the OHVN Zone

Cherif Haidara is the loan officer at the BIAO responsible for handling credit to OHVN AVs. The BIAO became interested in lending to small farmer groups from a desire to diversify their clientele beyond urban-based businesses who were proving to become greater credit risks as the Malian economy continued to deteriorate.

Criteria for initiating loans to groups are that: a village association be officially recognized by OHVN as evidenced by a signed agreement (*procès verbal*) between the village association and OHVN; the village association has received training from CLUSA in financial management; and they be engaged in cotton production.

The first BIAO loans were granted under the USAID-sponsored guarantee fund in 1989/90 for cotton inputs to four or five village associations in the Mandé zone. Because the experience was so positive (99 percent repayment), BIAO lending expanded to over 200 million CFA for the 1992/93 season.

This year, however, the BIAO has run into serious problems because the CMDT has been late in paying OHVN producers. As of April 30, 1993 (the date that 92/93 loans were due), 50 and 45 percent of short and medium term loans, respectively, were not paid. In theory, a stiff penalty is assessed on late payments. But BIAO will not enforce this because they realize that the situation is not the farmers' fault, they do not want to lose their clients, and this would only worsen farmer financial problems.

The BIAO values its OHVN clients and would like to continue serving them. However, unless the problem of late cotton payments is resolved somehow, it will be difficult to extend further credit. This is aggravated by the fact that CMDT places highest priority on paying farmers in its own zone, and a lower priority on paying OHVN farmers.

level group investments in a variety of small-scale economic activities (see Box 3-3). This transition is still underway, but as Table 3-1 makes clear, substantial progress has been made in shifting responsibility from OHVN to village associations for determining credit needs, and then going to banks to solicit, negotiate, and (using group solidarity as "collateral") repay loans. The amount of agricultural credit granted in the OHVN zone by banks nearly doubled between 1988/89 and 1991/92. Over the same period, group credit grew from 68% to 83%. One disturbing development, however,

[6] OHVN staff numbers were supposed to be reduced from 404 persons in 1988 to 212 by 1992. As of March 1992, personnel numbers stood at 336 and there were no plans for further reductions that year (Waddell and Audette 1992). This is partially explained by the fact that the Project Paper called for abolition of the credit section, but it was later decided to retain it so small villages without AVs could continue to have access to credit.

[7] Short-term credit is used for purchasing fertilizer, seed, and herbicides while medium-term credit is used for agricultural equipment and investment in draft animals. The two banks currently making agricultural loans in the OHVN zone are the Banque Industriel de l'Afrique de l'Ouest (BIAO) and the Banque Nationale de Développement Agricole (BNDA). The former is a commercial bank and the latter is the national agricultural development bank.

occurred in 1993. Due to falling cotton prices on world markets, and maintenance of producer prices at the same level as five years ago, CMDT has had great difficulty paying farmers in a timely manner.[8] In consequence, a number of village associations were late in repaying loans because they had not been paid for their 1992/93 harvest as of July 1993. This bodes ill for credit delivery in the 1993/94 cropping season.

Table 3-1
Agricultural Credit Amounts Under the DHV Project,
1988/89 to 1992/93

Source	Type	88/89	89/90	90/91	91/92	92/93	
OHVN	Individual (ST)	123,508,784	107,097,510	89,628,748	75,123,560	77,500,935	
	Individual (MT)	6,142,088	5,408,325	3,803,766	8,109,805	3,120,505	
	Total Individual	129,650,872	112,505,835	93,432,514	83,233,365	80,621,440	
	Group (ST)	45,630,510	10,075,790	39,788,690	4,937,638	82,306,481	*
	Group (MT)	1,832,000	2,503,000	1,877,704	1,578,175	2,183,475	
	Total Group	47,462,510	12,578,790	41,666,394	6,515,813	84,489,956	
Banks	Group (ST)	204,757,310	285,911,790	324,875,362	372,214,587	276,245,810	
	Group (MT)	26,421,000	12,659,000	38,125,100	38,154,940	41,103,660	
	Total Bank	231,178,310	298,570,790	363,000,462	410,369,527	317,349,470	
Total in OHV Zone		408,291,692	423,655,415	498,099,370	500,118,705	482,460,866	
Percent Group		68.2%	73.4%	81.2%	83.4%	83.3%	**
Percent Banks		56.6%	70.5%	72.9%	82.1%	65.8%	*

* In 92/93, collective OHVN credit is overstated, as a large part was actually supplied by the BIAO for farmer purchases at OHVN warehouses. However, BIAO refused to reimburse OHVN directly, so much of BIAO credit shows up as OHVN credit in the table.

** An additional 63,000,000 CFA was supplied to groups: 42,000,000 by banks for "activites economiques" (activities other than agricultural inputs and equipment); and 21,000,000 CFA by PRMC to finance cereals banks. Of the 42,000,000 CFA for economic activities, 11,500,000 CFA went to women's groups.

Source: OHVN.

Efforts have only just begun to more fully involve women in the credit program. Their share of agricultural credit remains negligible -- although cases are reported whereby village associations re-loan funds to women's groups. However, women have begun to obtain credit for economic activities other than conventional agricultural ones (Section 3.4). In 1992/93 they garnered nearly a third of the FCFA 42 million lent by banks under a A.I.D. guarantee fund for such activities. This represents a strong upward trend from only some FCFA 2 million in credit lent to women in 1990 and 1991.

Village associations have also taken on increased responsibility for negotiating prices and delivery terms with input suppliers. An informal federation of village associations has even been formed to negotiate bulk purchases with input suppliers (see Box 3-4). While it is GRM policy to gradually

[8] This situation should improve as a result of the 50 percent devaluation of the CFA franc which occurred in January 1994.

Box 3-4
The Private Sector and Agricultural Input Supply in the OHVN Zone

The *Compagnie Africaine de Distribution* (COMADIS) began operations in 1985 and sells fertilizer, pesticides, agricultural equipment, and hybrid seed to farmers in Southern Mali and the Niger Delta. It is a purely Malian concern whose establishment would not have been possible prior to the 1980 dissolution of the SCAER input supply monopoly. The firm's general director, Cheikh Amadou Ingoïba, stated that under SCAER, input import and delivery was exclusively an affair between the RDOs and large foreign (usually French) firms. According to Mr. Ingoïba, since the mid-1980s, the number of small Malian firms engaged in input supply has mushroomed.

Beginning in 1989, COMADIS began direct fertilizer sales to OHVN zone AVs, negotiating separate deliveries to 22 of them. In subsequent years, the AVs decided to group together in a *Bureau de Coordination* and negotiate bulk sales. The number of OHVN AVs doing this grew from 71 in 1990/91 to over 200 for the 1993/94 agricultural season.

Representatives of the Bureau usually begin shopping around at COMADIS and other input suppliers in February and March. Once prices have been negotiated, the input supplier prepares a purchase order for the entire shipment and individual purchase order for each AV in both French and Bambara. COMADIS arranges for transport by sub-contracting to truckers. Purchase order copies are kept by the AV and also sent to the Bank supplying credit. If the papers are in order, the Bank authorizes delivery of the inputs. Once the inputs arrive in the villages, the Bank pays the input supplier directly by check.

Mr. Ongoïba claimed that the system generally works smoothly, although sometimes the paperwork for bank credit authorization is late. This year, OHVN farmers are facing a very serious problem due to late payment for last year's cotton crop. Mr. Ongoïba has advanced his firm's own funds while he waits for farmers to be paid and credit payments to be authorized.

shift input and output marketing responsibilities from RDOs to village associations and private enterprise, this process is clearly more advanced in the OHVN zone than in any other. In the CMDT zone, for example, input distribution is still managed entirely by CMDT. Even though there are four to five times as many village associations in the CMDT zone as in the OHVN zone, the phenomenon of village associations determining their own credit needs, compiling their own credit dossiers, and independently negotiating with banks is less frequent than in the OHVN zone. A.I.D. can rightfully claim a good deal of credit for these developments. Establishment of the loan guarantee fund for village association agricultural and other group activities in 1988/89, organizational management training for village associations through the Cooperative League of the USA (CLUSA), continued support to functional literacy training, and insistence that village associations take a more direct role in dealing with banks and suppliers are key to this noteworthy success. It constitutes an institutional innovation (versus a purely technological one) that is critical to establishing the preconditions for true sustainability.

It is less clear whether the measures to professionalize the extension system have in fact transformed OHVN into a more effective agency for technology transfer. For example, the head of the OHVN Extension Division stated that he was "only 50% satisfied with the technical level" of his field staff (personal communication, July 1993). A recent and very thorough-going report by Bingen et al. (1992) is even more critical, claiming that OHVN is still plagued by an inability to clearly articulate extension messages and to obtain and act upon feedback from farmers. The report casts serious doubt on whether the efforts initiated under the DHV project have really resulted in meaningful and positive change in the extension service, for a variety of reasons. These are briefly outlined below, and many are illustrated in the next chapter.

It is unclear how well-targeted are OHVN technology recommendations. Farming systems in the zone are quite varied. With the exception of messages about cotton, it is uncertain to what extent OHVN differentiates its extension themes by agroecology or producer resource endowments. Almost none of the score or so technical sheets that the CDIE team examined had any clear discussion of these parameters. When queried about this oversight, OHVN headquarters extensionists stated that

recommendation domains are explained orally in training sessions for all field personnel and, moreover, that all personnel are instructed in all techniques regardless of agroecozone or socioeconomic constraints because of the frequent reshuffling of extensionists among OHVN sectors. The use of chemical fertilizers offers an example of the implications of a failure to differentiate recommendations by agroecozone. Currently, fertilizer is recommended for both the north and the south. Yet its application to millet and sorghum in the north is not economical because of the absence of cotton cultivation. Only a cash crop like cotton justifies the initial expenditure; foodcrops rotated onto the previous year's cotton field benefit from the residual effects of the fertilizer. In any case, no credit is currently available for cropping in the north, and few farmers there have sufficient cash flow to pay for fertilizer prior to planting. As a result, OHVN notes only a 5% adoption rate of fertilizer in the northern sectors.

Similarly for recommendations by farm category. The agreement signed between OHVN and DRSPR/Sotuba for the years 1987-92 identifies five recommendation domains, plus a farm classification scheme based on levels of livestock endowments (IER/DRSPR 1992, "Comite Technique Regionale...). But again, it is unclear to what extent such differentiation has found its way into the advice given out by extension agents.[9]

Overall, one has the impression that deciding which techniques should be emphasized in which regions and with which producers is left largely to the discretion of sector and subsector personnel. While a certain amount of decentralized decision-making is desirable, care should be taken to assure that research findings on appropriate target audiences and recommendation domains are respected. This is especially true in light of the low level of education and technical training among many OHVN field personnel and, certainly, the new farmer-agents.

OHVN technical sheets are not widely available and many are poorly prepared. Bingen et al. found that most sector offices do not have complete sets of these sheets, that many subsector chiefs had none, and that even headquarters staff in Bamako were unable to assemble a complete set. In a CDIE team interview on 07/30/93 with the latter group, the chief of the extension division stated that as of June 1993, organized notebooks of these materials had gone out to all sector offices. However, the team did not find any of these in the field; nor could the head of the division produce a well-organized copy for inspection. Also, in the four villages the CDIE assessment team visited, village-level farmer-agents and other neo-literates requested that the information be made available in the major local language, Bamanakan. According to an interview (07/30/93) with personnel of OHVN's functional literacy component, DNAFLA has printed booklets covering a number of OHVN extension themes in Bamanakan. Again, however, these were not to be found in most of the villages visited by the CDIE team. According to extensionist and A.I.D. interviewees, problems of cost, distribution, owner-/archivership, and field-storage (termites, moisture, theft) are to blame.

[9] In one village visited, extensionists proudly noted a large, new corral "improved" by being built of wire mesh. This new technique had been "adopted" by the wealthiest man of all in the village. To pay for the structure, he had taken out a 4-year loan of nearly FCFA 100,000. He was already well in arrears and, like his peers in another village visited by the CDIE team, he and his co-villagers ruefully concluded that "Even the richest people cannot afford this luxury for their animals."

The CDIE team also noted problems with the preparation of the technical sheets available for examination. These sheets are written in a great diversity of levels of sophistication, with no standardized format.[10]

It is unclear whether many of the technologies and practices extended promise farmers any real benefits. Results from 1990/91 and 1991/92 FSR trials on fertilizer applications showed little discernible improvement over traditional practices. The "improved corral" described above is another case in point. In large part, this problem appears to result from poor approaches to applied research.

Feedback mechanisms within OHVN are not fully developed. There is little evidence of feedback flowing from farmers back to OHVN headquarters, or of exchange of experience among field agents. For example, 45% of extension agents surveyed by Bingen et al. reported knowledge of traditional practices that were superior to the recommended "improved" practices. However, less than 10% of these individuals communicated these impressions to other agents, headquarters, or to IER researchers. It was also Bingen et al.'s judgement that OHVN monthly program meetings failed to solicit feedback from agents; rather they were times for receiving top-down orders, and communication was essentially one-way.

The new mass and/or indirect extension techniques have met with mixed success. For example, despite the fact that numbers of and attendance at OHVN annual **field days** have steadily grown in recent years (see Table 3-2), farmers say that they have taken on a largely ceremonial tone, with high-profile visits from Bamako dignitaries dominating the proceedings, in lieu of substantive educational activities or real farmer-to-farmer or farmer-to-extensionist exchange and feedback (Bingen et al. 1992:21). Men who have gone on OHVN **farmer-to-farmer visits** report that they are interesting and valuable, but note they are not followed up (ibid.). As for the OHVN system of **pilot farmers**, no one (including OHVN extensionists) was quite sure who these individuals were, although a 1992 OHVN/DCDR report claims a total of 230 such model farmers throughout all 10 sectors of the zone. The OHVN also reports the existence of 540 **extension groups** or *groupements de vulgarisation*, composed of

Table 3-2
Annual farmer Field Days in the OHVN Zone

	Field Days			Attendance			
Year	South	North	Total	Men	Women	Total	Average
89/90	4	1	5	1963	229	2992	598
90/91	6	1	7	2308	489	2797	399
91/92	5	2	7	3798	459	4257	608
92/93	5	2	7	4682	618	5300	757

Sources: OHVN data base and annual reports.

[10] Most of the sheets examined by the team displayed no date. Thus, it was unclear whether the information was current. Moreover, most sheets gave no author or even institutional provenance. On occasion, the CDIE team found two sheets on the same technology (whether by the same agency or not was impossible to say) with conflicting recommendations. Sometimes, too, the information given was very sketchy, with critical steps for correct implementation omitted; at other times, sheets were loaded down with chemical and economic formulae that were irrelevant for field application. And typically the sheets offered little or no instructions on how or if procedures should be modified to fit differing agroecological or socioeconomic contexts.

10 to 15 male or female members.[11] But according to reports by subsector chiefs and outside researchers, group meetings and attendance are spotty. Less than half the group may show up, with an average attendance of 6; and membership constantly changes as some farmers drop out (Bingen et al. 1992:20).

Alternative extension media have not been tried. Audio-visual aids and radio programs are commonly used with some success by extension services in other Sub-Saharan African countries. OHVN has so far made minimal use of these communication tools, due in part to the long-delayed establishment of a promised audio-visual unit and staffing for it.

The position of the new village-level farmer-agents is precarious. Besides the mass and indirect extension mechanisms discussed above, the main viaduct for the broad-based spread of knowledge and practices in sustainable cropland management throughout the OHVN zone is envisioned as local-level participation through village organizations and their member-designated *animateurs/animatrices de vulgarisation agricole* (hereafter "farmer-agents"). The latter are to become the main contact-point between OHVN extensionists and producers -- and thereafter, for farmer-to-farmer spread of such knowledge and practices. However, the nascent corps of village-level farmer-agents is still on shaky footing. This situation is discussed in detail in Section 3.4.3 as a corollary to the emergence of autonomous local institutions in the form of farmer service cooperatives.

Development of Transport Infrastructure in the OHVN Zone

In addition to developing extension capacity for technology transfer, road construction and maintenance has been an important component of the two A.I.D. projects assisting OHVN. Through early 1993, 559 kilometers of rural roads had been constructed or rehabilitated. Of these 434 km were rehabilitated during the first phase and 125 km during the second phase of assistance to OHVN. It is estimated that these roads have a direct impact on 35 percent of the population of the project zone (Fofana, 1993).[12] Roads are recognized by the GRM, A.I.D. and villagers as a fundamental pre-requisite for all other economic development activities in the zone.

While a number of studies have attempted to estimate the impacts of rural roads in the OHVN zone, assessing the aggregate impact of improved roads on incomes, production, and changes in farmer strategies remains problematic due to data limitations, and the difficulty of sorting out the impact of roads from other variables such as rainfall, changes in relative prices of farm commodities and purchased inputs, and cereals market liberalization. After examining production and yield data in three sectors affected by OHVN road construction interventions (Kangaba, Bancoumana, and Kati), Fofana (1993) concludes that production has increased through a combination of intensification and extensification. The data, plus qualitative accounts from villagers, lead him to hypothesize that increased access to markets as a result of improved roads is a major contributor. Data from an earlier study by OHVN (OHVN, 1986) that compares yield and area trends from 1980/81 to 1984/85 indicate a similar pattern.

[11] These should not be confused with the village groups.

[12] Populations are categorized as being directly impacted upon if they live within a 10 kilometer radius of the road.

Because of this mix of intensification and extensification, it remains unclear to what extent the roads component has contributed to accelerated degradation of the natural resource base through extensification and mining soils to achieve short-term gains in production.[13] As farmers sense they have soil productivity problems and good land also becomes increasingly scarce, they may seek to intensify production on existing plots, making them more open to NRM techniques.

One thing is clear: an important pre-condition for the dynamism of village-level organizations (examined in the next section) that has developed in the southern OHVN zone is the existence of a major cash crop -- cotton. This implies the need for ready access to markets, and thus good transport infrastructure. While the GRM and A.I.D. have been quite successful in improving the quality of road infrastructure, a sustainable system for road maintenance is still not in place: OHVN zone road maintenance remains heavily dependant on A.I.D. financing. To date, villager involvement in road maintenance has been disappointing. OHVN is presently engaged in studying the various options available for road maintenance after the departure of A.I.D.. Until a viable plan is identified and implemented, this will remain the "Achilles heel" of sustainable agriculture development in the OHVN zone.[14]

Local Institutions

One of the major thrusts of the DHV Project has been the creation of local producer organizations of several types: village groups, village associations, and (the rare) *tons villageois*, as per GRM policy on cooperative organizations as the engine of rural self-development. As noted in Section 2.2 and as indicated in Box 3-2's chronology of the Haute Vallée, A.I.D. has been a leader (beginning at least as early as 1983) and extremely vigorous actor in making this policy reality.

Under the DHV project, A.I.D. assistance to cooperative development has been implemented through the National Cooperative Business Association, better known in Africa as the Cooperative league of the U.S.A. (CLUSA). Below, the current numbers, types, structure, functions, and distribution of village associations and village groups are first outlined. Next is a brief overview of A.I.D.-funded CLUSA and DNAFLA contributions to the development and strengthening of these local institutions. Finally, the roles of these local-level institutions and their farmer-agents in extending sustainable cropland management practices are described and discussed. Throughout, attention is given to both male and female farmer-members.

Cooperative Village Organizations

As of June 1993, CLUSA reports that it is assisting a total of 237 village organizations in the OHVN zone. This compares with 11 such pilot organizations in the Haute Vallee as of 1984, and 47 as of

[13] Data problems may also exist due to the difficulties inherent in obtaining valid estimates of agricultural production, area, and yield data.

[14] Options to be explored as potential contributors to a comprehensive road maintenance scheme include: villagers operating road barriers in the rainy season to minimize damage from trucks travelling on wet roads; levying a tax on producer prices and using these funds to constitute a road maintenance fund; taking a share of local taxes (the *taxe de développement* levied at the *cercle* and *arrondissement* levels) for a road maintenance fund; transporters paying increased taxes at the local level; and villagers collecting tolls (personal communication, Sidi Kanouté, Transport Division Chief, OHVN, July 1993).

1988. CLUSA field operations began only in March 1989. These 237 local institutions are comprised of 178 village associations and 59 village groups.[15]

Structurally, village associations largely follow the official guidelines laid down for *tons villageois* (see again Section 2.2). Each is governed by its members through a General Assembly and is overseen by an Administrative Council elected by the assembly. Besides the council, an village association also has a number of promoter/managers (*animateurs*) to take charge of overseeing specific village association enterprises. These positions are usually filled by younger males who are literate and numerate. In consonance with traditional *ton villageois* organization, currently most council and promoter positions are filled by members of each village's founding or "noble" lineage and their relatives.

In theory, village association membership is open to all village inhabitants who accept the organization's operating rules and regulations. Typically, women as well as men are included as village association members, at least *pro forma*. In fact, however, to date village associations "primarily include [male] cotton growers and influential villagers" (Proposition par CLUSA au Project DHV: 1993-97:4).

village associations oversee the village literacy center and engage in a variety of collective economic activities to generate funds for, e.g., supporting the literacy center, recompensing (in some village associations) literacy and village association promoters and managers, and making collective investments in community infrastructural or social-welfare projects. They are also expected to assist the state in the maintenance of local roads.

Paramount among Haute Vallee village association activities to date, however, is self-provisioning in agricultural equipment and inputs, mainly for cotton production. Indeed, since the pilot village association programs initiated under the OHV Project in 1983, cotton production and marketing have formed the primary stimulus to village association formation in most of the zone. Self-provisioning is accomplished ideally via commercial credit extended directly by banks. Other village association economic activities typically include: for village associations in cotton-producing areas, overseeing local marketing operations such as weighing, grading, loading, accounting; working collective cereals fields or garden enterprises; instituting village cereals banks; keeping a community store of basic consumer goods and/or a pharmacy; and retailing some of the agricultural inputs obtained through village association group credit to non-village association-members and other individuals and to the local organizations of neighboring villages who do not yet qualify for credit.[16]

Two important developments have arisen among village associations that bode well for the longer-term goal of a rural federation of farmer cooperatives. First, beginning in the agricultural season of 1991/92, a group of CLUSA-trained village associations spontaneously formed an informal alliance

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[15] In interpreting this total of 237 it should be noted, first, that there may be more than one village group in a given village (see below); second, this figure does not include still other, uncounted village associations that have not yet received CLUSA assistance but that nevertheless may receive credit from banks, OHVN, or other sources. However, some of the latter reportedly comprise "artificial" village associations in the sense that they have organized solely for the purpose of gaining easier access to credit. They do not carry out any other economic or civic activities and they hold few or no general assemblies each year.

[16] For greater detail on the range and frequency of different village association economic activities by sector, gender, etc., consult CLUSA/Mali, 1993, "Rapport Trimestriel 01/01/93-31/03/93."

for the purpose of pooling their annual orders for agricultural inputs and equipment. They are thereby able to negotiate significantly lower prices for inputs from different vendors and to demand custom-made agricultural equipment that better suits their farming systems directly from manufacturers. Named the *Coordination des Associations Villageois de la Haute Vallee*, this informal federation is presently comprised of 140 CLUSA-trained village associations (07/20/93 interview with CLUSA Technical Assistant for Small Business Administration). Second is the phenomenon of "non-CLUSA village associations" and villages without village associations affiliating with the so-called CLUSA village associations. The former can thereby gain access to agricultural inputs and equipment for which they could not themselves qualify for credit, or they may obtain these items at a better price than they could otherwise.

In contrast to village associations, village groups are much smaller (minimum 5 members, with a current range of 5 to 50+) preliminary or special-interest groups. They mimic village association structure on a lesser scale, limited mainly to an administrative council of some sort, one or more managers, and in the case of those engaged in agriculture-related activities, often a designated contact farmer to serve as the go-between for OHVN extensionists.

During the OHV Project, village groups were essentially viewed as the kernel around which village associations would eventually coalesce. As of 1992 under CLUSA efforts on the new DHV Project, village groups have taken on added importance as an alternative mechanism for stimulating, involving, and extending skills to certain groups who cannot currently qualify for full village association status and credit. Examples are the poorer producers in a community, villages that do not raise cotton (as in the arid northern sectors of the OHVN zone), full-time gardeners, artisan castes, petty merchants, and most notably, women. Thus, today one can find villages with one or more village groups. Many less well-endowed groups can qualify for modest credit -- if not from banks, then from less stringent PVO sources (notably, in the north, Plan International de Parainage) or from the OHVN -- with which they, too, can begin economically viable activities to build up their organizational and managerial skills and their memberships' earnings. In fact, village groups tend to be the predominant mode of local organization in the north. And they appear to be the most effective choice for organizing income-earning activities for women.

Particularly for women's village groups -- which reportedly numbered about 25 as of March 1993[17] -- examples of the types of enterprises undertaken to date are: collective fields and sometimes associated compost pits; purchase and managment of a grain mill and/or karite and *pourghere*-seed (*jatropha curcas*) presses; gardening co-ops; both large and small ruminant fattening, sometimes along with cultivation of leguminous forage crops; savings clubs; and more recently, purchase of an ox team and plow for use on members' individual and collective fields and for renting out to earn village group income.

Both OHVN extension and especially CLUSA have made a herculean push across the past two years to incorporate rural women into village-level activities and into institutional training, credit, and outreach programs. While overall results are still somewhat slim, this represents a distinct advance over the total lack of such efforts in past. From CLUSA reports, conversations with farmer-

[17] This figure of 25 represents village groups that CLUSA has assisted to date. However, an OHVN WID specialist cited a 1993 total of 100 women's extension groups, many of which are also active in credit and economic activities. It is unclear exactly how CLUSA and OHVN distinguish and collaborate in these WID efforts and from where what kinds of enterprise training and credit reach which types of women's groups. One gets a sense of competition between OHVN and CLUSA, but with each operating under procedures.

informants in the field, and interviews with OHVN WID specialists and field-extension personnel, one has the sense that this long-awaited initiative could be approaching a real take-off point, assuming that other elements such as functional literacy for women are brought up to speed.

Without question, much of the gender-equitable dynamism and the democratic spirit of village groups and village associations today -- and indeed, their very existence -- are due directly to the A.I.D.-funded CLUSA technical assistance. CLUSA was included in the DHV Project "...to assist the pre-cooperatives...of the Operation Haute Vallee zone...to become self-managed and economically viable [and to]...contribute directly to the achievement of several of the project's objectives, most notably the development of rural, private sector organizations capable of managing credit, input supplies and marketing functions" (CLUSA/Washington, "Operational Program Grant to CLUSA," 1988:i).

CLUSA attempts to promote a truly participatory approach to rural development. In order to further the establishment of democratic rural cooperatives, CLUSA adheres to the principles outlined in Box 3-5. These principles are put into practice through a carefully designed approach to co-op development and management that centers on pragmatic and concrete step-wise training for co-op board members, managers, promoters, and members. Box 3-6 summarizes the impressive results of CLUSA's principled, systematic approach to the development of strong, democratic local institutions in the OHVN zone. The data represent cumulative achievements between March 1989, when CLUSA began its first village-level field operations in Mali, and June 1993.

Box 3-6

CLUSA Achievements in Cooperative Development as of June 1993

- 237 village associations/groups assisted, representing more than 100% of EOP target
  - 178 village associations and 59 village groups
  - 28 organizations in the north, 209 in the south
  - 75 of the 237 are women's organizations -- either a village group or a women's group within a village association
- 2551 managers trained, representing 98% of EOP target; 267 or 10% of these are women
- Nearly 10,000 members regularly participating in general assemblies and other planning and review events, and thus exercising participatory decision-making powers and absorbing training themes.
- 673 activities spanning 32 different types initiated; one-third of these types pertain to sustainable agricultural production, transformation, distribution, or consumption.
- A rapid increase in the formation of women's groups and in their initiation of economic activities.
- FCFA 777,677,394.00 of credit placed with CLUSA-assisted AVs/GVs to date.
- An average of 17% profitability -- with a range of 3% to 51% -- of village association/group economic activities. (Calculated from a random sample of 10 local organizations' profit:investment ratios.)

Sources: CLUSA/Mali, 1993, "Rapport Trimestriel 01/01/93-31/03/93," with updates to June 1993 and 07/27/93 additions by Mr. Jeff Felten, CLUSA Technical Assistant for Small Business Administration.

Local Literacy Centers

As indicated above, functional literacy and numeracy underpin all other village association economic activities and their accompanying business-management and organizational tasks and training -- not to

Box 3-5
The CLUSA Approach

Principles of Cooperative Development

Cooperative development provides both economic and social benefits, but it begins by laying a sound financial foundation. The unique nature of co-ops is that the business owners are also often the customers. Since co-op economic activities are chosen to satisfy member needs, the co-op's development as a business concomitantly contributes to the advancement of its members' social welfare. The more solid and dynamic the business aspects of the co-op, the more it can undertake non-economic, social projects.

Multi-functional co-ops work. Experience in Africa demonstrates that multi-functionality is not only possible but necessary to the successful growth and functioning of co-ops. Moreover, it is in consonance with many traditional African systems of community organization. Further, a mix of activities chosen by members themselves and structured to contribute to their own welfare has the advantage of keeping the co-op visible throughout the year. A tangible activity like running a village shop with basic consumer goods serves as a concrete reminder of the co-op and its benefits while also allowing management skills to be practiced yearround rather than just during marketing periods.

A sense of real ownership by the members is key. The key to unlocking the energy and commitment of co-op members is their realization that the co-op does indeed belong to them and that they (and not any outside organization or person) can make the decisions, chose their economic activities themselves, and profit from them.

Top-down hierarchical interactions are reversed. Field staff who work with co-ops must develop a respect for and understanding of the wisdom of the village. This means they must acquire new attitudes, techniques, and skills. Freed from conventional top-down modes of assistance, staff can increase their own analytic powers, and the critical flow of corrective information upward can begin. Relatedly, assistance should be given only at the request of members, not "pushed" onto them.

A direct relationship between the co-op and its lenders and vendors is invaluable. So that a co-op will continue after technical assistance is withdrawn, lenders and vendors must come to accept it as an independent and credit-worthy commercial client. Conversely, co-op members must often overcome their initial feelings of intimidation and mistrust vis-a-vis lenders and vendors. This two-way relationship can be facilitated by bank staff's or suppliers' personally visiting the co-op, and examining its economic activities firsthand; conversely, members can also visit and transact business directly with lenders and vendors in their offices and stores. For the co-op, this kind of contact emphasizes the importance of the transactions and the need to honor them. It is also a signal of the independence and autonomy of the co-op and of its status as a valued client.

Training Principles and Subject Matter

Discrete training steps are necessary. Project interventions in the field and co-op economic activities can alike be broken down into discrete steps and management units that facilitate learning the necessary knowledge and skills. Mastery of intermediate skills keeps learners from feeling overwhelmed and gives them a sense of progressive accomplishment, which motivates them for more advanced learning.

Functional literacy/numeracy is an integral component of co-op management training. Without the ability to read, write, and do basic mathematics, co-op members cannot manage their own economic activities. Acquisition of these skills by a few allows the co-op to manage itself. And their acquisition by the membership in general ensures honest management that is in the best interest of all.

All training is concrete and immediately relevant to co-op activities. The first round of literacy/numeracy training should be based on the management of whatever economic activity the co-op has chosen to pursue. And every training session in co-op management corresponds directly to the level and types of each co-op's activities at that point in its evolution. In the OHVN zone, hands-on training is in the areas of understanding roles of *animateurs*, identifying economic activities, preparing feasibility studies and bank dossiers, accounting and bookkeeping, and managing meetings.

Adult training models and experiential pedagogic techniques are used. These embrace active "learning-by-doing" exercises, question-and-answer sessions, role play, lesson repetition, and the use of humor, proverbs, images, etc. to communicate lessons in as many different and engaging ways as possible.

Sources: Compiled from: CLUSA/Washington, 1988, "Operational Program Grant to CLUSA," p. 2-5; CLUSA/Mali, n.d., "Principe de Pedagogie Paysanne", and CLUSA/Mali, n.d., "Programme de Developpement des Associations Villageoises de la Haute Vallée." " Operational Program Grant to CLUSA," p. 2-5, and from CLUSA/Mali, n.d., "Programme de Developpement des Associations Villageoises de la Haute Vallée "

mention the planned transfer of on-the-ground extension responsibilities from OHVN to village

association farmer-agents. As with base-level agricultural extension, under the DHV Project it is envisioned that the costs and responsibility for village functional literacy classes will progressively devolve to local organizations, as economic activities add to local treasuries and as a critical mass of neo-literates and -numerates (i.e., graduates of functional literacy training programs) crystallizes to serve as instructors.

In fact, an internal A.I.D./DNAFLA/OHVN evaluation in May-July of 1991 reports 162 independently functioning centers, supported by selling the produce from collective village or functional literacy fields and/or by PVO donations (Diallo et al. 1991, Executive Summary 1991:15-16).[18] By late 1992, reportedly more than 500 functional literacy centers were to be found in the zone, of which 65% were for men, 20% for women, and the remainder for mixed-sex groups (Bingen et al. 1992:31). However, from CDIE team interviews, it was unclear how many of these 500 centers were fully or regularly functioning. And Bingen et al. 1992:32 found the OHVN's reported figure of over 13,000 neo-literates hard to believe in light of earlier studies and field observations. There is a strong sense that little may have changed since a 1984 internal evaluation by DNAFLA identified field-level problems as follows.

> Despite high numbers of *auditeurs* claimed...results are minimal if measured in terms of actual numbers of people literate and numerate. ...a majority of *auditeurs* are extremely weak in arithematic [sic] skills, as well as deficient in reading and writing. Many of those tested in the villages visited were completely illiterate. A number of centers had essentially gone out of business. Many villagers and *animateurs* had given up because...there were no post-literacy materials available. There was extreme discouragement from the absence of visits and supervision from the OHVN Coordinator (Ronco Consulting Corporation 1985:107).

Also as of late 1992, nearly 50% of functional literacy attendees were between age 10 and 20 years. Women were said to constitute over 20% of neo-literates and over 10% of village literacy teachers. Based on the CDIE team's interviews and field visits, however, these gender figures seem somewhat overblown. One document indicates that even among CLUSA-trained village associations in the south -- OHVN's traditional stronghold -- there is today an average of only two literate females per village association (Proposition par CLUSA au Project DHV 1993-97, 1993:14); another knowledgeable source estimates that across the OHVN zone as a whole, this figure is only .5 female literates per village.

During both the OHV and the present DHV Projects, DNAFLA has operated under contractual agreements with A.I.D./Mali and/or the OHVN to supply functional literacy training in Bamanakan to villages in the project zone. In the field, DNAFLA activities are directed by 10 ZAF (*zone de alphabetisation*) chiefs, corresponding to today's 10 OHVN sectors, plus two female promoters of women's literacy. The field staff is backed by a headquarters staff of four and a driver. Current DNAFLA methodology begins with training in the fundamentals and then proceeds to technical specialization, traditionally with courses held from two to five days a week during the dry season.

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[18] As of 1991, the list of donors, PVOs, and other external agencies contributing to literacy programs in the zone included: AFRICARE, CECI (Centre d'Etudes et de Cooperation Internationale), CFAR (Centre de Formation et d'Animation rurale), Peace Corps, GANS (Groupe Action Nord Sud), GTZ, ILO, JAC (Jeunesse Agricole Croyante), Secours Islamique, UTAH-Alliance, World Vision International (Diallo et al. 1991a, Executive Summary 1991:24).

Beginning in 1987/88, DNAFLA and/or CLUSA have also experimented with intensive 45 and 50-60-day courses, particularly for women (after Bingen et al. 1992:30).

Bingen et al. present a more detailed assessment of DNAFLA (and later, CLUSA) efforts in functional literacy across the LOP of the OHV and DHV Projects. Suffice it to say here that the quality and delivery of functional literacy services in the zone have had a rocky history -- as Box 3-2's chronology might suggest. In addition to the problems already noted, over time the functional literacy component has been plagued by: both external and internal problems of financial accreditation and management; abuses and disagreements over vehicles; serious and repeated questions about the competence and motivation of staff; confused and uncomfortable roles and relationships between DNAFLA and OHVN; salary disparities among field staff; seeming staff shortages; lack of refresher training for staff; and lack of up-to-date training materials and resultant use of outdated techniques (Bingen et al. 1992, Diallo et al. 1991a&b, Ronco Consulting Corporation 1985).

Box 3-7
Rural Demand for the Three Rs

Ronco Consulting Corporation, 1985

> *...as to preparation of materials resulting from applied [ag] research...booklets of this kind...would be beneficial. The demand for this kind of information was made clearly manifest in the villages visited... Even in the less organized villages, where there was no Ton yet receiving...credit, ...there was at least one animateur, and villagers indicated an interest in pursuing functional literacy training if materials both for literacy and post-literacy training were again made available* (p. 108-109). *They [also] wanted to increase the number of women enrolled in functional literacy classes...* (p. 108).
>
> *What is most striking is the willingness of villagers to slog along, and devote time and other resources to an activity that has received virtually no support from the OHV for the past two years* (p. 109).

McCorkle and Kamafe, 1986

> *All...villages emphasized that, once "entente" is achieved, the most difficult problem to overcome in organizing a successful ton villageois is the lack of literacy and numeracy skills in the population. ...respondents repeatedly mentioned acute shortages in these two skills for operating ton villageois and other community organizations...* (p. 75-76).

Diallo et al., 1991a

> *...the demand for literacy is very strong in the rural world [of Mali]* (translated from the French, p. 14).

Bingen et al., 1992

> *...women have a "real will...to learn to read, write, and calculate" ...as evidence of this, the earnings from womens' [sic] collective activities support 12 of the 101 women's centers. [But] ..."the women's needs for functional literacy surpass the possibilities offered by the DHV Project"* (translated from Traore 1991:16, cited in Bingen et al. 1992:33).

President and members of the village association of Digan village, 1993

> *Please tell OHV for us that, for our future to be secure, more attention and assistance must be given to "alphabetisation"* (translated from Bamanakan in 07/19/93 CDIE team interviews in Digan, Subsector of Sugula, Sector of Welesebugu).

As of the time of the CDIE team's research, reportedly a number of older, operational and managerial problems had been laid to rest by a new contracting mechanism. And beginning in 1990

and accelerating in 1992-93, DNAFLA has made a serious push to get technical extension information into print in Bamanakan and to develop some new training materials. As noted earlier, however, some cost, distributional, storage, and other problems appear to persist. Fortunately, so does rural people's unflagging hunger to learn the 3 Rs and put them to practical use, as documented in Box 3-7 down through OHV/DHV history.

DNAFLA's initial achievements, nigh upon 20 years ago, reportedly were impressive. But document reviews and CDIE team interviews with knowledgeable sources suggest that across the years, in the Haute Vallée, DNAFLA has not lived up to its early promise.

Village-Level Extension Institutions

Communities with village associations or *tons villageois* that are considered sufficiently literate, numerate, and technically advanced are today charged with acting as the base of the OHVN extension system via their designated male and (more rarely) female farmer-agents. A village gains this *auto-encadre* status based on the recommendation of the sector chief, who takes into account the competence of their farmer-agents and the proportion of the community who have adopted recommended OHVN technologies and practices. The 1993 "Rapport Critique des Realisations du Project DHV: Seminaire Annuel des Cadres de l'OHVN" informs that nearly 50 communities -- all in the south -- attained this self-managing extension status between 1989/90 and May 1993 (p. 7), spanning a total of 238 farmer-agents of unspecified sex (p. 15). This makes for approximately 4 to 5 farmer-agents per *auto-encadre* village.

This figure may be misleading, however, in that a single individual has been known to fill as many as eight different promoter roles. As a farmer-agent, he/she has two main responsibilities: extending the OHVN's NRM themes, and reporting production and other agricultural statistics to the subsector chief. But as one of the still-exceedingly-scarce village-level literates and numerates, this individual may also be responsible for: overseeing the process of ordering and distributing inputs and equipment, selling the cotton harvest, keeping the accounts for village-level credit and collecting credit payments; doing the accounts for and/or running the village shop, pharmacy, mill, or cereal bank; taking rainfall measures; collecting taxes; giving first-aid or health and hygiene training; registering community births and deaths; running forestry or seed multiplication and marketing programs; teaching functional literacy/numeracy; and more (Bingen et al. 1992, Diallo et al. 1991b).

One cannot help but wonder how much attention people with two or more of these roles can actually pay to their assignment of extension while also continuing to meet daily farm and family responsibilities. In villages visited by the CDIE team, multi-role incumbents complained that the press of their duties had not left them even enough time to cultivate their own fields!

Small wonder, then, that farmer-agents have begun to report feelings of "burnout" and exploitation among their ranks. Many complain that they have been saddled with all the duties -- but none of the pay or privileges -- of the OHVN's former base-level extensionists. Indeed, according to Bingen et al. (1992:20) in many cases, villagers have come to view their farmer-agent as part of the OHVN system, rather than as part of the village structure; in consequence, they may not feel responsible for supporting them financially. Some of these farmer-agents interviewed by the CDIE team noted that currently they are not even reimbursed for their out-of-pocket expenses for travel, food, and lodging to attend meetings, workshops, negotiate with input suppliers, and so forth. However, it was also reported that a few village associations pay their farmer-agents at least something for their time and

Box 3-8
Village Associations and Farmer-Agents in the OHVN: One Community's Story

The history of village associations and technology transfer systems in the community of Sugula is illustrative of their evolution in the cotton-growing areas of the OHVN generally. Sugula was one of the first of a dozen communities selected to participate in a pilot program of village service cooperatives in the early 1980s, which the OHVN undertook at A.I.D. urging as per the GRM's new policy on cooperative development. As a showcase site, Sugula was showered with development assistance of all sorts. Soon, it had a vigorous co-op that successfully assumed fiscal responsibility for group agricultural credit. Initially, group credit was extended to Sugula by the BNDA via OHVN; today the village association deals directly with commercial banks for its credit needs. As of 1993, thanks to the new system of group credit, 90% of farm families were fully outfitted with all basic animal traction equipment.

Also in the mid-80s, the village association took on the farmgate cotton-marketing functions (grading, weighing, loading) previously carried out by OHVN agents. In exchange for these services, the village association earns a rebate on its sales of cotton to OHVN. In addition, the community boasted a dynamic women's wing of the village association, who managed cooperative gardening and grain milling enterprises. All these activities were bolstered by a strong village-wide push for functional literacy.

By 1993, however, some problems had emerged in the village association. The women's gardening and milling initiatives had collapsed, in large part due to inadequate planning for replacement costs of the garden's pump, windmill, and fencing, and the mill's engine. Perhaps over-confident of its new-found independence, Sugula initially rejected CLUSA training in business management and economic feasibility analysis when it was first offered in 1989.

In addition, the CMDT liquidity crisis has had a severe impact on the village association treasury and for all the initiatives that it is now expected to support. Payments to the village association for its 1992/93 harvest have been exceptionally late. Making matters worse, the cotton rebate (the main source of funds for the village association treasury) appears to have been drastically slashed this year -- farmers were unaware of why this is so.

Villagers are worried about this turn of events because they note that they can no longer increase cotton production, and thereby maintain village association earnings, merely by clearing new land. Across the years, as more and more families acquired animal traction, all of the land suitable for cotton was put to the plow and fallowing is now rare. Farmers report that "Now many people have soil problems" and "Everyone knows the land is not as good as before."

It is unclear how Sugula's farmer-agents will now be compensated for the considerable time and out-of-pocket expenses they incur takin care of village association business in extension, lining up agricultural credit, and input and output marketing. For the past several years, Sugula's farmer-agents received a percentage of the cotton rebate. But divided among the total of eight promoters of various sorts, this dwindling sum has now shrunk to almost nothing.

Sugula's functional literacy efforts seem to be struggling, too. While women seem to have made some gains since 1986, as of 1993 the AV officers, agents, and promoters (all male) are largely the same ones as in 1986. While this situation is doubtless due in part to longstanding power and prestige structures among village lineages, a shortage of upcoming neo-literates/numerates also appears to be a factor.

Depressed cotton revenues coupled with OHVN transfer of a number of their previous functions to the community has led to some generational tension in Sugula's village association. While elders today confess that "The young know the [outside] world better," they are asking "Why should we have to pay our own children to do our bidding?" For their part, the "children" -- the young adults who serve as farmer-agents, functional literacy teachers, and other promoters -- wonder how they are to get their own fields sown and harvested, their own children clothed and fed.

Confronted with such problems, Sugulans are not standing idle, however. There is a fresh dynamism and dialogue within the community. The village association has now accepted CLUSA's offer of training, in hopes of better managing its economic activities. The AV has also appointed a representative to the newly formed national cotton growers association, to keep better informed of events in this vital subsector. To restore and protect the productivity of their land, people are actively experimenting with new soil conservation and fertilization techniques brought by research and extension. Elders and younger men discuss their differences openly and frankly. And farmer-agents and promoters feel free to air their concerns directly to OHVN and other government agencies. While Sugulans recognize there are problems to be overcome, they clearly have a greater sense of empowerment than ever before.

4. ADOPTION AND IMPACTS OF SUSTAINABLE AGRICULTURAL PRACTICES

This chapter provides an overview of sustainable agriculture technologies promoted through A.I.D.-supported projects and programs in Mali. The chapter also reviews the rather undependable data that currently exist on adoption rates. The remainder of the chapter is devoted to three case studies on promotion and adoption of sustainable agriculture technologies. These case studies demonstrate the complex interplay of institutional, organizational, and economic factors that encourage (or inhibit) technology adoption.

Overview of Technologies

The inventory of sustainable agriculture technologies that have been promoted by A.I.D./Mali over the years range from improved food crop varieties, to soil conservation practices, to animal traction (see Table 4-1). In a sense, it is difficult to discuss the contribution of any one practice in isolation of the others. This is because the concept of "sustainable" practices has little meaning when divorced from the farming system in which the practice is occurring. Animal traction, for example, may contribute to sustainability if supplemental measures are taken for returning organic fertilizer to the soil. In the absence of such measures, animal traction quickly leads to soil degradation and deteriorating agricultural productivity.

Many of the practices have only been recently introduced. Specifically, most soil conservation and natural resource management techniques only began receiving A.I.D. support in Mali in the DHV project, initiated in 1988. The only practices with a fairly long history of A.I.D. support are animal traction (promoted in the early 1980s) and improved seed varieties (some of which received support through SAFGRAD, also in the early 1980s). It is therefore difficult to assess impact at Levels III, IV, and V. This is mainly because not enough time has passed for farmers to hear about techniques and either adopt or reject them. In addition, and as will be discussed below, there are data availability problems on adoption rates and impact.

Evidence on Adoption of Technologies

Table 4-1 reports numbers of farmers adopting OHVN-sponsored technical practices for the 1991/92 agricultural campaign. Although the growth rates of farmers adopting appear very impressive, a number of observers have noted problems with the data and techniques employed by OHVN for measuring adoption.

First, according to Bingen et al (1992), continued use of traditional practices is often attributed to OHVN extension. One example is live fences. It is not clear what criteria OHVN uses to differentiate between live fences planted traditionally, and those planted using an extended innovation. Other examples are application of organic fertilizer on fields to maintain soil fertility, animal traction, and various cultural practices for cotton. These practices pre-date OHVN, and it is unclear what the marginal contribution of OHVN has been.

Another problem concerns the counting of DRSPR research trials and infrastructure donated by NGOs as "adoption" of OHVN themes. Obviously, in such instances, it is too early to tell whether a farmer will incorporate the technology in question into practice on his own fields.

In addition, OHVN tends to count up adoption of packages as opposed to individual components within a technical package. It is commonly observed throughout the world that farmers frequently pick and choose components within a technical package. According to one DRSPR scientist, if a

Table 4-1

Number of Farmers Adopting OHVN Technical Themes, 1991/92

	Baseline (1988)	Objectives	3 Year Total	Percent of Objectives
Improved cotton seed varieties	3,720	4,645	2,474	133.3%
Improved cereals seed varieties	4,000	4,630	1,763	124.5%
Animal traction with cultural practices	3,458	5,128	3,613	137.9%
Animal traction with improved varieties	692	2,522	2,820	139.3%
Cultural practices	1,437	2,437	1,518	121.3%
Knowledge/use of organic/chemical fertilizers	6,000	7,470	3,783	131.0%
Anti-erosion practices	0	445	1,508	338.9%
Improved gardening techniques	270	2,051	1,781	100.0%
Animal fattening	68	233	489	239.1%
Improved fallowing practices	0	165	60	36.4%
Compost pits	0	315	1,039	329.8%
Improved animal husbandry	0	240	1,129	470.4%
Stabling for manure production	71	301	152	74.1%
Ruminant fattening (for women's groups)	0	950	546	57.5%
Pesticide use	4,000	4,985	4,883	178.2%
Herbicide use	0	220	2,867	1303.2%
Parcelling	0	100	572	572.0%
Improved animal corrals	0	0	44	ERR

Source: OHVN, "Rapport Annuel d'Activités: Campagne Agricole 1991-1992," Bamako, 1992 (page 11).

given package has, say, four components, and the farmer only adopts one of the four practices, that farmer is weighted as having accepted 25 percent of the package. When this is aggregated, four farmers adopting one of the four components is counted as one out of four farmers adopting the entire package. Obviously, such a method hides potentially valuable information about which parts of a technology package are being picked up upon, and which are being discarded.

Bingen et al (1992) also report that perceived technical shortcomings may limit farmer adoption. One example is the recommendation of flat plowing, while evidence exists that traditional practice of ridge plowing is more effective in conserving moisture. Bingen et al also cite the use of seeders which involves plowing that removes most crop stubble (to prevent the seeders from jamming and skipping). However, this may have a negative impact on soil and water conservation.

Finally, reporting is strictly in terms of numbers of farmers, meters of infrastructure created, numbers of units created, etc. There is little qualitative analysis in terms of farmers' attitudes towards the various technologies, nor economic analysis of farm-level profitability of individual technologies. Moreover, OHVN adoption studies do not record spillover effects in nearby villages that have not directly benefitted from extension services.

One revealing example of where a heavy emphasis on numbers may lead is provided in the 1991/92 annual report. In Table 4-1, the two themes with the largest reported gaps between objectives and achievements are improved fallowing practices and small livestock raising by women. Rather than inquiring as to why these have not been widely accepted (there may be serious constraints of a non-technical nature such as limited access to credit by women's groups, or lack of economic feasibility),

the report states that these two themes will receive greater emphasis in the next year. Such tight adherence to generating numbers in an effort to impress the government and donors can lead to misallocation of scarce extension resources and wasted effort on the wrong technical themes.

Once a technology has been accorded fiche technique status, one gets a sense that further reflection ceases with regard to appropriateness, farmer attitudes and adaptations, and farm-level profitability. Information on these are often of greater value than adoption rate figures for assessing the effectiveness and appropriateness of extension messages, and identifying which technologies should receive increased emphasis in future years. Moreover, extension agents quickly get the message that the incentive structure rewards reporting of impressive numbers. Under such a system, garnering feedback from farmers on what works and what does not and transmitting such information up the chain of command is more apt to be penalized than rewarded.

That said, one can question whether attempting to rigorously quantify the OHVN contribution to technology adoption is worth the cost. Concentrating on identifying ways to institutionalize systems that encourage qualitative and timely feedback from farmers on techniques that make a positive contribution to agricultural sustainability will almost certainly have a higher medium and long-term payoff for increasing extension service responsiveness to farmer needs. Devoting more energy to developing institutional innovations that reward the right types of behavior (Level II actions) in the extension service is probably more beneficial than moving headlong into Level III. If conditions are still not right for widespread adoption, it is better to put resources into preparing these conditions than measuring adoption.

In the next three sections, case studies are presented that highlight some of the key reasons why potential exists for some innovations to be widely adopted. Case studies concern the following technologies: rock lines for prevention of soil erosion through flash-flooding; organic fertilizer techniques and crop-livestock interactions; and introduction of streak-resistant improved maize varieties. These areas were chosen because they reflect the complex interplay of a number of institutional, organizational, and economic factors that encourage (or inhibit) adoption of technologies that could possibly have widespread positive impact on the physical environment and the well-being of rural Malians.

Case Study: Rock Lines and Prevention of Soil Erosion

As discussed in the previous sections, OHVN has been extending a number of NRM technologies since the beginning of the DHV project in 1988. One theme that has received particular emphasis, and which seems to have been greeted with some enthusiasm by villagers is the construction of rock lines[20] to prevent soil erosion from heavy rainfall. The OHVN 1991/92 annual report claims that OHVN assisted in the construction of 1,711 meters of bande en cailloux, and 19,740 meters of diguettes from 1989/90 to 1991/92.[21] Widespread extension of rock line systems in Mali began in

[20] These appear under different titles in French: *lignes en cailloux, lignes pierreux, and bandes en cailloux.*

[21] Converting meters constructed to hectares protected from soil erosion is not a straightforward task and is subject to some arbitrary assumptions because the distance between rock bands is a function of the slope of the land and other factors. However, assuming that 100 meters are needed to protect one hectare, this works out to roughly 210 hectares protected.

1986 in the CMDT zone with the beginning of the Anti-Erosion Project,[22] co-financed by the Dutch Royal Tropical Institute and the GRM, and implemented by CMDT. Development and dissemination of the techniques in Southern Mali built on prior experience in Burkina Faso. Extension of the improved technique began in the OHVN zone with the new emphasis placed on NRM in the DHV project.

Villagers have expressed interest in the practice for several reasons. First, constructing rock lines is a traditional practice in the project zone as well as in other parts of Mali (especially on hill sides). The technology extended by OHVN is a refinement of traditional practice, so farmers are already familiar with the basic concept and its potential benefits. Second, rock lines have a dramatic visual impact, usually within the first rainy season after they are installed. After one or two heavy rains on lightly sloped land that is somewhat degraded, farmers can quickly gauge the difference. Often, effects of the "with" and "without" situation are readily apparent on adjacent fields -- providing ready-made demonstration plots for extension. Third, many villagers in the OHVN zone, especially those practicing animal traction on cotton, have been experiencing soil erosion problems for some time now.[23] Widespread adoption of animal traction has led to extensification of production. However, with population pressure on the land, improved access to markets (as a result of road construction) and the greater distances required for travel to outlying fields, farmers appear to be searching for ways to maintain fertility on outer fields -- fields that were formerly cultivated in a bush-fallow style of shifting agriculture. In other words, farmers in much of the OHVN zone appear to be making a gradual transition towards intensive cultivation and soil conservation practices. Finally, unlike some other sustainable agriculture technologies, purchased material requirements are minimal, so cash and credit constraints are not present.

The damage caused by flash floods rarely limits itself to a single farmer's field. The rush of water begins at the top of an incline,[24] and then winds its way through other fields located downstream, washing away topsoil and either leaving sand deposits or bare bedrock in its wake. Newly planted crop seedlings are either washed away or buried by the sand. These "temporary" rivers usually dry up in the space of a few hours.

The sheer velocity of the current renders soil conservation measures taken on any single field powerless to break the force of the water. For this reason, construction of rock line systems must be carried out collectively by all the farm families whose fields are threatened. The presence of cohesive village-level organizations greatly facilitates this task. The DRSPR/Sikasso farming systems team has found that strong village associations are prerequisites for the successful establishment of rock lines and a number of other sustainable agriculture practices (van Campen, 1991).

Recent research by DRSPR/Sikasso, however, highlights a potentially disturbing development. After great initial interest in constructing rock lines, farmers in the CMDT zone gradually lost enthusiasm in constructing more. This was because of the time-consuming and very arduous nature of the work

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[22] *Project Lutte Anti-Erosive dans le Mali-Sud* (PLAE). For an overview of the project approach, see van Campen (1991).

[23] One farmer the assessment team spoke with commented that although there was less rain now than fifteen or twenty years ago, the problem of washed-out fields was more common.

[24] The slope may be very slight. This phenomenon is not confined to areas with steep slopes (although the problem will obviously be greater on steeply sloping cleared land)

required to collect rocks in bush areas and transport them to fields (actual rock line construction takes relatively little time). Transport is either carried out by carts borrowed from the village, or by headload (in baskets).

Table 4-2 provides some basic cost and labor data from trials in villages for alternative modes of transporting rocks to fields for rock line construction. DRSPR/Sikasso researchers found that it took twice as much labor to construct rock lines using carts for transporting rocks as it did for trucks (21 labor days versus 10 to complete 100 meters) and four times as much labor for headloads as for trucking (nearly 40 days). They also found that the efficiency of headloads declined precipitously when rocks were transported distances greater than 50 meters. Because sufficient supplies of rocks can rarely be found at such short distances from fields, the headload mode is really not a viable option.

Table 4-2
Construction Costs and Labor Requirements for 5 Hectares of Rock Lines With Truck, Cart, and Manual Transport

		Truck	Cart	Manual
Meters required	1,100			
Meters constructed		557	258	141
Rental value		30,000	5,500	0
Labor hours		272	272	272
Labor days (5 hour day)		54	54	54
Total labor costs		27,200	27,200	27,200
Cost per meter		103	127	193
Per 5 hectares		112,962	139,419	212,199
Labor days per 100 meters		9.77	21.09	38.58
Meters per labor day		10.24	4.74	2.59

Note: Assumes average spacing of 50 meters, plus extra rock line at top of network.

Source: Adapted from: van der Poel and Kaya (1992), page 11.

The motivational factor was very important. Villages whose rocks were trucked to fields willingly supplied twice as much labor as the villages that used carts.

Using the DRSPR/Sikasso cost data, and combining them with typical farm budgets in the OHVN zone,[25] the assessment team calculated internal rates of return for the three transport modes. Major simplifying assumptions included:

- Cycles of five years of cropping, followed by three years of fallow, over twenty years;

- Labor valued at 500 CFA per day; and

- Use of rock lines prevented the loss of 10 percent of yield revenues annually, beginning in the second year after installation.

Unfortunately, reliable research data are not available for determining the effects of rock lines on soil loss prevention over time. It is fair to say that the 10 percent assumption errs strongly on the side of conservatism. Over several years, the effects of flash flooding can devastate yields and eventually result in abandonment of entire parcels. As other analysts have noted, it is often an "either/or"

[25] See Annex B for typical farm budgets in the OHVN zone, as well as internal rate of return calculations. The authors are indebted to Vic Duarte, USAID/Mali Program Economist, for the farm budgets.

question: one either makes the necessary investment in soil conservation, or the entire field is gradually lost (Christophersen, 1988).

It is also difficult to get a statistically valid estimate of "average" length of fallow periods in the project zone. Many farmers in the Ouellessebougou zone, for example, may farm a given field for as much as 15 years before giving it a rest. The five year cropping/three year fallow assumption probably overestimates fallowing under current farmer practice in the OHVN zone. This has the effect of biasing downwards the benefits of installing rock lines as revenue flows during fallow are zero, while they are strongly positive in all years except during the year of initial investment.

IRR calculations for all three transport modes are very high: 95 percent for trucking; 75 percent for carts; and 45 percent for headloads. The potential economic profitability of rock lines appears beyond question. The most important constraints to adoption appear to be organizational and psychological, and concern the amount of time it takes to install the network. Because the networks can be quite long,[26] and the time-consuming nature of the work (with carts) often make it difficult to complete them in a single dry season. This can create tension in groups working collectively as the sequencing of benefits favor some segments of the group over others: those with fields at the top of the slope benefit most quickly as rock line construction begins at the highest point. It is possible that a group can work diligently together during one dry season and partially complete the network. However, when the rains come, those at the end of the network continue to suffer from flooding. The following year, those at the high end (who already have rock lines in place) have less of an incentive to assist those with fields on the low end.

An additional source of tension concerns those who volunteer their carts and draft animals. Hauling rocks quickly depreciates carts and weakens animals. Few villagers want to volunteer their equipment and animals over any significant period of time.[27]

While village cohesion is essential (or at least cohesion among the group of farmers whose fields are threatened), the problems cited above argue for installing the networks as quickly as possible so that the rewards are equally distributed, and not staggered over time. The DRSPR/Sikasso FSR team advocates partially subsidizing rock line installation by paying 75 percent of truck rental costs. Villagers would contribute 25 percent of the rental value, plus provide all manual labor for collecting, loading, and off-loading rocks, as well as constructing the rock lines.

There are additional reasons why one might want to use public (or donor) subsidies to encourage acceptance of this technology. First, semi-subsistence farmers are usually under severe labor constraints. This often makes it difficult for them to engage in activities with potentially high medium and long-term pay-offs. In such cases, short-term pay-offs only become readily apparent after soil degradation has become severe. Soil conservation efforts fall in this category. Tropical soils tend to be more fragile than those in temperate regions (Anderson and Thampapillai, 1990). For small farmers who have major capital and labor constraints in the short-run, there is little immediate incentive to engage in soil conservation. Such farmers may only initiate conservation measures after

[26] In Falan, the assessment team saw one that was approximately one kilometer in length, with dikes at approximate 100 meter intervals.

[27] In the villages where DRSPR/Sikasso conducted their study, the average distance traveled for each cart trip was 850 meters (one-way) and 37 trips were required to complete a total of 258 meters.

soil productivity has seriously declined.[28] Carefully designed subsidy programs can increase incentives for farmers to adopt soil conservation measures in the early stages of soil degradation. This saves farmers lost output, and lowers the cost of creating soil conservation infrastructures because they are usually less expensive when applied to slightly degraded soils as opposed to heavily degraded ones.

A second reason for subsidizing truck transport relates to equity. Cart transport limits access to rock line technology to those who have carts and draft animals (as mentioned above, headloads are not a viable option for widespread adoption). This penalizes poorer groups in rural areas. At the same time, these may be the groups with the greatest need for soil conservation technology because rural poverty is often highly correlated with limited access to productive land.

The analysis above does not address the potential benefits of introducing one or more sustainable agriculture technologies on the same plot of land. Obviously, placing rock lines in fields is not sufficient to guarantee sustained high yields over time: this technology does not deal with soil fertility concerns. Measures to maintain soil fertility such as use of organic and chemical fertilizers, field rotations and associations that incorporate leguminous crops and nitrogen-fixing trees (such as acacia albida) may introduce interaction effects. Planting of windbreaks is important for containing wind erosion. As Box 4-1 illustrates, the labor costs of installing rock lines can be reduced by putting in brush lines (*fascines*) where water velocity has been reduced already by upstream rock lines.

Box 4-1
Prevention of Soil Erosion in Fallan

Daouda Traoré, a farmer in Fallan (Ouellessebougou sector), constructed a series of three *fascines* on his one hectare sorghum field two years ago. These are lines of vegetative debris (tree branches, millet stover, etc.) held in place by wooden stakes. Adjacent to his field is a series of rock lines that stretch nearly one kilometer over other villagers' fields. Although the land is only gently sloped, flashflooding threatened to completely destroy a number of fields in Fallan until the rock lines were constructed by the villagers with the assistance of OHVN extension staff. Traoré estimates that his sorghum yields had fallen to only 15 70 kg sacks two years ago. However, since installing the *fascines*, he estimates that he will be able to harvest 25 sacks of sorghum, provided that rains are good. Because the power of the flooding is dissipated by the time it reaches his field, he has installed *fascines* which are not as strong as rock lines, but take considerably less labor to install than rock lines.

Using data from a variety of Sahelian countries (data from Mali came from IER research stations in Mopti and Sikasso), Christophersen (1988) found that contour ridges (a variation of sorts on rock lines) in combination with organic fertilizer, and in combination with acacia albida were of great potential financial attractiveness to farmers. Using break-even analysis, he concluded that only a 51

[28] One project in the OHVN zone currently working on soil conservation extension is the KfW-funded Agro-Ecological Project (PAE). Among the criteria for village selection is that the village must have fields that are suffering from serious soil erosion. Project personnel do not feel that villagers experiencing only moderate erosion have enough motivation to fully bear rock dike construction costs themselves (personal communication from PAE/Ouellessebougou, July 1992).

kg/year yield increase was required to make the organic fertilizer combination profitable. Combining contour ridges with acacia albida produced a synergistic effect on yields, as the ridges retained rainwater while the acacia albida contributed soil nutrients (rainwater retention also helped tree seedlings grow faster).

Shaikh et al (1988) conclude that technologies are available in the Sahel that can lead to more sustainable agricultural development and improved natural resource management, but for a number of reasons, cases of widespread adoption are rare.[29] They argue that a number of conditions are necessary for these technologies to have a wider impact. These include: the availability of markets; cost sharing between local populations, government, and donors for those interventions with potentially high social pay-offs; risk sharing as all new technologies have an element of inherent risk and Sahelian smallholders are especially risk-averse (for good reason); and a long-run commitment to the building of institutions capable of taking promising technologies and exploiting them to their fullest potential. The next case study addresses a number of these points, both in detailing a success story, as well as a potential missed opportunity.

Case Study: Soil Amendments and Crop-Livestock Interactions

Cotton provides nearly 40% of all of Mali's export earnings,[30] yet it consumes 80% of all inorganic fertilizer used in the country (Kieft and Coulibaly 1993), most of which is imported. Even with extensive chemical and mineral fertilization, however, nutrient balances in Malian cotton lands are on average negative in nitrogen and potash (ibid.). There is progressive soil acidification due to poorly equilibrated applications of nitrogenous chemical fertilizers with urea. Erosion losses figure in this negative picture, too. Without attention to erosion, increased or more balanced applications of inorganic fertilizers alone cannot guarantee a sustainable nutrient cycle. Equally important is soil structure. In the long run, production of cotton and food crops grown in rotation will fall due to structural shortage of organic matter in Malian soils. Taken together, these considerations have led to predictions that, if conventional cotton fertilization and production practices continue unmodified, soil productivity in Mali's cotton-growing areas will collapse in 30 years (van der Pol, cited in Kieft and Coulibaly 1993:15). And as one farmer-interviewee in the southern OHVN ruefully remarked, "Pas de coton, pas de paysan."

Heretofore, armed with animal traction, Malian cotton-growers confronted soil problems simply by clearing new land. Yet with increasing scarcity of productive land, this option has become less viable. Cotton harvests have already begun to decline on fatigued land in long-time cotton-producing villages. As Sugula farmers reported to the CDIE team, "Many people now have soil problems." Staff of the German-financed Agro-Ecology Project confirm that awareness of 'soil problems' is growing among villagers of the southern OHVN (07/19/93 interview).

Cotton farmers today are thus more open to ideas for improving the soil via use of organic fertilizers; they are also concerned to diversify into other plant and animal crops. Representative of many southern OHVN farmers, male farmers of Falan gave the following response when asked what they anticipated as future needs for assistance from agricultural research and extension:

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[29] The only technology that had been widely accepted was improved clay cookstoves in rural Mali.

[30] Livestock are second, accounting for approximately 27% of total formal-sector commodity exports as of 1992 (AID/Bamako 1992).

> Now we want to learn how to increase the productivity of our cotton fields, not just their size. Also, OHVN should help support our gardening efforts (women farmers seconded this) because cotton is going down and people are afraid. We also need help with our stock-raising. There are many diseases among our animals, and we have problems feeding them (07/12/93 interview).

Of course, with chemical fertilizer price increases beginning about 1986, farmers throughout the Haute Vallee have found yet another powerful incentive to "go organic." Significantly, under the cattle-fattening credit program of the Mali Livestock Sector Projects, 50% of farmers interviewed in six Banamba villages (northern OHVN zone) by a midterm evaluation team "...listed the manure from the cattle fed as the most important benefit of the program. ...Only two informants did not list manure at all." One farmer further observed that "the increase in his yield using manure from the program cattle in one year was such that his family 'could not eat all the grain'." Like their southern colleagues, Banamba farmers also cited problems with animal feeding (Brett-Smith et al. 1987:89-90).

DRSPR scientists have increasingly addressed soil and animal husbandry issues through research on organic fertilizers and crop-livestock interactions. Their efforts have also built on R&D under the series of livestock projects supported by A.I.D./Mali between 1974 and the present.[31] Four of the resulting research-enhanced and OHVN-extended interventions are described and discussed below in relation to their socioeconomic and agroecological recommendation domains. They are: composting (*compostieres*); stabling of work and/or feeder animals, in combination with manure pits (*fosses fumieres*); improved corrals (*parcs ameliores*); and cultivation of the leguminous (nitrogen-fixing) forage *Dolichos lablab*, commonly termed *doliki* in Bamanakan.

All four of these soil amendments build on existing local practice. Throughout Mali, the use of a traditional sort of compost is common. Known in French as *terreau*, this material comes from housesite middens and is almost universally applied to maize plots near the home and to gardens. Likewise for manure. But traditionally, manure has typically been used in an agronomically inefficient way: it is rarely stored, mixed with litter, composted, or incorporated into the soil. The absence of such practices means that organic matter and nutrients in the manure are lost to leaching, evaporation, and microbial action (McIntire et al. 1992). What research and extension have brought to traditional techniques are ways to increase the quantity and quality of organic fertilizers by enhancing the speed and thoroughness of decomposition. The *doliki* case, too, finds a parallel in indigenous practices of cultivating food/feed crops like groundnut and cowpea, both of which are prized for their hay as well as their pulses.

Composting. Composting is also termed "artificial manure" on one OHVN technical sheet. In fact, the CDIE team found two OHVN technical sheets on this subject, with somewhat differing

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[31] USAID support for Mali's livestock sector actually started in 1963, with a $2 million loan for constructing a small laboratory and training specialists in vaccine production. But major support began with the establishment of the Mali Livestock I Project (1974-1982) in response to the great drought of the early 1970s. This project focused on increasing the production and marketing of cattle through on-farm and commercial feeding programs in Regions II and IV. Mali Livestock II added improved range management and expansion into new lands to this mandate. Besides components to improve veterinary services and GRM institutional management, the follow-on Mali Livestock Sector Projects I and II begun in 1982 also incorporated a cattle-feeding credit program and research on forage production and related socioeconomic factors. The current APEX (Animal Productivity and Export) Project begun in March 1992 places even greater emphasis on feed/forage access and use, and on effective NRM practices and policies to improve crop-livestock integration.

instructions.[32] According to one sheet, this technique is mainly targeted for farmers who own few or no animals.

Depending on which technical sheet one reads, composting consists of piling biodegradable materials onto a piece of plastic sheeting or a cement or beaten-clay surface; alternatively, one can simply dig a hole and, as one agent put it, "Just throw anything into it." According to OHVN technical sheets and CDIE team interviews, "anything" includes the straw, stover, or husks from sorghum, millet, maize, rice, and cotton; field weeds; fresh and dry bush grasses and old roof thatching (which traditionally was burned instead); household and garden wastes; material collected from village garbage dumps; at least a little fresh manure from whatever animal species are available; and depending on which sheet one consults, some stove ash, ammonium sulphate, PNT (a local rock phosphate), and dirt.

It is uncertain to what extent which of these methods and recommendations have been adopted in the OHVN zone. However, throughout Mali, the use of a traditional form of compost is common. Known in French as *terreau*, this material comes from housesite middens and has been almost universally used on maize plots near the home and in gardens. Likewise for undecomposed manure. What research and extension have brought to traditional techniques are ways to enrich the resulting product by enhancing the speed and thoroughness of decomposition.

Stabling and Manure Pits. According to OHVN extensionists, this technology is designed for owners of a limited number of work or feeder animals: the relevant technical sheet lists cattle, horses, and sheep. This strategy consists of keeping animals tethered on a hard, well-bedded and -drained surface under a hangar -- a high platform that, when covered over with stover, hay, or bush grass forms an open shed. This structure does double-duty as shade for the animals and as a storage area for the plant materials to be presented as feed or thrown down as bedding. According to the OHVN technical sheet, for cattle 4 to 6 kg of stover etc. should be provided per day (up to 1.5 metric tons per head per year). The accompanying manure pit should be located near the stable. The OHVN technical sheet claims that 6 to 12 tons of manure is produced for each bovine stabled.[33]

Farmer-interveiwees appeared to agree that this technology is a good idea. Falan farmers, for example, told the CDIE team that, between 1987 and the present, they have installed approximately 40 manure pits in their village, using both the above- and in-ground designs. One Falan farmer expressed great satisfaction with the fact that this technique had allowed him to cut his use (and costs) of commercial fertilizer in half, with no decline in cotton yields. Sugula's farmer-agent reported that 14 families have installed stables and manure pits in the past few years. For Digan-1 village, this figure was 10. Farmers in the northern village of Tomba said they began experimenting with this technology two years ago, adding the twist of establishing a collective manure pit to supply fertilizer

[32] Entitled *Les Engrais Organiques* and *Fiche Technique: Le Compost*, both sheets are undated and give no institutional provenience. Neither do they offer any agroecozone or farming-system specifics about different methods or ingredient-composition of compost preparation or rates of decomposition. This is important climatic differences affect decomposition rates and because these organic items often have competing uses (e.g. as mulch, livestock feed, construction material).

[33] This figure seems suspect, however, in light of OHVN research and demonstration data that indicate a yield of 6 to 10 tons per manure pit with several head of cattle (Christophersen 1988:15).

for the collective field of the community women's group.[34] They further observed that, with their newly acquired animal traction equipment, "Plowing demands much from the earth, so you must put fertilizer back into the soil. The organic fertilizer has more 'energy' than the chemical products."

Improved Corrals. In their most basic form, "improved" corrals are nothing more than slightly sunken ($\approx$40 cm) structures of wooden fencing or *banco* into which straws, stovers, and hays are periodically thrown down as the muck builds up (every 10 to 15 days or so).[35] These plant materials serve, first, as cattle feed and/or bedding, and second, after being thoroughly trampled in with the dung and urine of the corral, as a rich organic fertilizer.

According to interviewees with years-long experience in the various A.I.D./Mali livestock projects, this technique derives from traditional stockraising practices among farmers of the semi-arid north. There, small ruminants have long been nightly quartered in tiny wooden-fenced corrals next to the front door of the home, where women provide them supplemental feedstuffs and bedding. Women then collect the resulting fertilizer to spread on their kitchen gardens and condiment fields. Improved corrals essentially represent an expansion of this traditional crop-livestock interaction to cattle and outfields, with the addition of new information as to how to increase the quantity and, especially, the quality of the fertilizer.

OHVN extensionists note that this strategy is geared for farmers with relatively large herds (35 head or more, although an OHVN technical sheet also gives instructions for corrals for 10 and 20 head) and extensive croplands for supplying necessary by-products and wastes. For efficient fertilizer production, 550 kg or the equivalent of 7 donkey-cart-loads of stover are required per head of cattle per year (undated, un-authored OHVN *Fiche Technique du Parc Ameliore*). To minimize drudgery, corrals should be located as close as possible to the fields to be fertilized. Beginning in April-May, the corral is mucked out and the fertilizer is transported bit by bit to the fields, where it is dumped in conveniently spaced piles to await spreading.[36]

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[34] Interestingly, Sugula's farmer-agent noted that, before independence when people were required to cultivate collective fields with which to pay in-kind taxes to the state, collective manure pits were also established for these fields. After independence, he says, "People left off this idea because it wasn't theirs." Further, it was negatively associated in their minds with colonial rule when – as an elder of Digan-1 recounted – "If you didn't pay your taxes, they would set fire to your house or kidnap your children and make slaves of them."

[35] According to a number of informants, this appears to be the original meaning of "improved corrals." However, the term is now applied to a wide variety of much more elaborate structures (cf. Bosma and Sanogo 1993), including those built with insecticide-treated wooden posts and wire mesh as per the OHVN *Fiche Technique du Parc Ameliore*. The rationale for the latter "improvement" is forest conservation via savings on the wood that is often used for corral construction. These kinds of "improved" corrals are not discussed here because in interviews in every village visited, farmers were vehement about their high cost (nearly FCFA 100,000 for 50 head). The wire mesh lies well beyond the reach of even the very richest households in the average OHVN village. Rough cost-benefit analysis and economic comparison with a common traditional alternative – *banco* corrals (see text) – showed the latter to be much more cost-effective. Thus, this practice merits no further discussion, except to note that the DED (Deutsche Entwicklungs Dienst) Projects Agro-ecologie in the southern OHVN are conducting some interesting experiments with corrals "constructed" of living fencing.

[36] According to CDIE interviews in the Banamba area, some farmers tackle the hauling problem in another way. They move the crops to the fertilizer instead of vice versa. At the beginning of the planting season, herds are transferred to temporary corrals and maize is planted in the rich soil of the improved corrals. Interviewees further pointed out that, if constructed of *banco*, the corrals also function as a useful windbreak for the maize.

***Doliki* Cultivation.** *Lablab purpureus* or commonly doliki[37] was one of the more promising dual-purpose food+forage legumes investigated by the various A.I.D./Mali livestock projects. A native of southeastern Asia, it was first introduced to Mali by ILCA, working under contract to these projects. The goal was to identify an alternative to cowpea, which has poor resistance to drought, insects, and certain diseases. Moreover, cowpea cultivation conflicts with the planting, hoeing, and harvesting of other crops; yet if reaped too late, most of its forage value is lost. Hence the search for alternative cultivars to increase legume production for: supplementing the protein-poor diet of bush hay and millet stalks given to cattle and oxen, especially during the November-June dry season; and improving soil fertility plus erosion and weed (especially *Striga* spp.) control via increased crop-livestock integration, thereby increasing or sustaining crop yields.

Doliki appeared promising for several reasons. First, both on-station and on-farm trials in Mali rendered *doliki* yields approximately twice those of cowpea (MLSP 1988:63). Second, once established, *doliki* is drought-tolerant; its deep root system can reach water sources as much as 2 m below the soil surface, thus permitting a longer production season at a time when many other herbaceous plants desiccate. Third, *doliki* requires little maintenance; its dense growth suffocates most weeds. And after harvesting, it readily re-grows. Fourth, its dried seeds are highly nutritious, both for cattle and humans; and its leaves are rich in protein and iron, and readily digestible (Brett-Smith et al. 1987 and CRZ/INRZFH 1989).

Perhaps most important from a farming-systems perspective is that (unlike cowpea) *doliki* can be planted after all other crops have been sown. Also, in semiarid areas, it can be harvested as late as December (Ulsaker et al. 1990:26), thereby avoiding some of the labor and rainfall problems of immediate post-harvest collection and curing (MLSP 1988:62).[38] On the negative side, in comparison with cowpea and groundnut hay, *doliki* leaves are much more prone to shatter and fall when dry.

Upon completion of its pre-extension trials conducted in conjunction with the DRSPR, the Mali Livestock Sector II Project trained all OHVN subsector chiefs in the technical practices for extending *doliki*. In the 1989/90 agricultural campaign, OHVN began full-blown extension. So far, however, seed shortages and other factors have hampered adoption. Currently, OHVN produces and distributes the seed *gratis*. Both APEX and OHVN hope that recipients will eventually multiply the seed and then share or sell it to other interested producers.

It is difficult to say how realistic this hope is. Seed multiplication entails costly applications of insecticide and one-time-only harvesting of forage. So far, *doliki* reportedly has found greatest acceptance in arid parts of Mali, where sparse rainfall limits cropping options and makes stockraising a key part of both household and rural economies.[39] The final evaluation team for Mali Livestock Sector II "observed wide use of dolichos" (1990:Annex VII-2). APEX staff claim that a vigorous trade in *doliki* seed has arisen in Banamba, primarily among large-scale or specialist cattle fatteners (Box 4-2).

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[37] Also known as *Dolichos lablab*; in common English, the "hyacinth bean."

[38] In sub-humid areas, however, apparently it must be harvested at roughly the same time.

[39] In the Banamba area, for example, livestock provide approximately 67% of the total net cash income of traditional producers (MLSP 1988:61).

APEX and OHVN personnel also entertain great hopes for the eventual widespread adoption of *doliki* in the cotton-growing areas. Although livestock currently plays different roles in the farming systems and household economic portfolios in the southern OHVN from those in the north, they have potential for diversifying production mix, particularly if world cotton prices continue to slump. According to APEX interviewees, the CMDT zone is already second in livestock population nationally; and CMDT currently subsidizes *doliki* seed production. In view of these facts, Mali Livestock II re-oriented its animal production program in 1988 to emphasize livestock nutrition constraints in agropastoral systems in the sub-humid regions of Mali, where there also appeared to be greater opportunities for developing forage technologies that can be incorporated into, or partially replace, traditional cropping patterns.

Box 4-2
The Women's Cooperative of Banamba

Two years ago, the 20-year-old, 53-member-strong women's Cooperative Teinturerie of Banamba City decided to try out cattle fattening. These Sarakolle (Soninke) market women had long ago given up dyeing as their major cooperative activity due to its low and uncertain profitability. "We needed to diversify," they explain. Under the tutelage of the local livestock agent and with OHVN assistance, the group obtained BNDA credit (FCFA 1,500,000 in 1992 and 2,116,000 this year) for purchasing animals for fattening. *Doliki* and manure both play a critical role in the women's new enterprise -- which is now their number-one income earner (followed by groundnut cultivation and petty commerce). The women cultivate a collective 1-ha field of *doliki*, substituting this nutritious grain legume for some of the expensive, commercially produced cottonseed cake conventionally used as a feed supplement. For plowing their *doliki* field and some other tasks, however, the women need help from their husbands. In exchange for the men's assistance, the women have worked out a real "win-win" arrangement between the sexes. "We give our husbands all the manure that is produced. This makes them very happy, and we keep the cash."

However, *doliki* did not rank high in the opinion of farmers visited by the CDIE team in the cotton-producing villages of Falan and Sugula. These individuals -- who were interviewed in small groups limited to farmers only (i.e. no OHVN personnel, farmer-agents, or other promoters) -- represented the most agriculturally innovative and well-to-do members of their community. They uniformly raised a number of problems with *doliki*.

While Falan interviewees felt that *doliki* cultivation was an "interesting" technology, it should be noted that Falan possesses larger herds than any other village in its area. Although Falan is anxious to identify new feed sources for its growing animal population, *doliki* does not appear to fit the bill. Farmers noted that it conflicts with their agricultural calendar, running into a critical labor bottleneck: "We have to do our other crops first, and we can't do both; it is too much work." They also cited equipment shortages in the form of the numbers of plows available to prepare the ground for *doliki* at the same time as the other crops. As one man summed up, "People must be fed before animals."

Interviewees in Sugula described how, beginning as early as 1986, many villagers had experimented with *doliki*, encountering additional problems. Besides the labor bottleneck, they found the work of harvesting and then storing the forage on top of hangars burdensome. Farmers also warned that, if an unseasonal "big rain" falls (a common event in the sub-humid south), both the field crop and the stored *doliki* rapidly rot, and livestock then refuse to eat it. In fact, according to the CRZ/INRZFH technical sheet (1989), *doliki* does not fare well on heavier soils with poor drainage (although one OHVN technical sheet recommends cultivating it in depressions) or on acid soils -- both common in the south. Sugula farmers also emphasized that seed is difficult to obtain. It has to be ordered each year from the OHVN and often arrives too late to be sown. Interviewees opined that if they could produce their own seed, *doliki* might be more attractive to them. Finally, they added one further worry: that the animals of other locals or of passing Fulani herders would graze the forage before

owners could get it all harvested. Neither land tenure laws nor traditional practices make provisions protecting crops purely for animal consumption or fallowing.

On the basis of farmer testimony, it is unclear what advantages *doliki* offers in the southern OHVN over traditional rotations with groundnut or groundnut/cowpea associations with cereals. According to farmers interviewed in the south, before the wide-scale adoption of cotton and the extension of maize as a field (versus a house plot) crop, groundnut was commonly rotated with sorghum and millet "so as to enrich the soil and reduce striga attacks." Both groundnut and cowpea are universally recognized by farmers as crops that "restore the soil." It would seem that in the southern OHVN, improved varieties of traditional food/feed crops may stand a better chance of adoption than alien ones that, moreover, do not permit farmers to produce much of their own seed.[40]

Summarizing the importance for sustainable croplands management of the soil fertility amendments and crop-livestock interactions promoted by A.I.D./Mali, the CDIE team concurs with the words of Ulsaker et al. (1990:31) that, although the use of compost, corrals, manure, and leguminous food/feed crops are not new to Mali, along with still other crop-livestock integration techniques, endeavoring to bring all these elements together in a systems context and promoting their use can be attributed to A.I.D. interventions. Indeed, research is to be commended for building upon the existing base of local knowledge and experience. This approach greatly increases the ease and likelihood of adoption of environmentally beneficial NRM practices and technologies. However, several issues arise related to extension performance and the potential biophysical and socioeconomic impacts of NRM interventions such as those described above.

First, with respect to the organic fertilizer technologies, the array of practices currently being extended can lead to confusion. It took the CDIE team a considerable amount of time to sort out one technology from another; and here, they have been presented only in their most minimal forms. Sorting them all out is probably at least equally confusing for extensionists and farmers. Add to this the fact that their appropriateness depends directly on agroecozone and socio-economic status, and who should receive which messages becomes even more unclear -- at least in light of the vague, incomplete, or even conflicting information presently provided by OHVN technical sheets.

For example, "recipes" for organic fertilizers need to be more clearly specified vis-à-vis such considerations local rainfall regimes and agricultural calendars, cropland topography and micro-level soil conditions. These factors must also be taken into account before recommendations are made as to whether stovers and other standing biomass should be removed from croplands in the first place, or whether these materials would better be left in place, grazed, and later plowed back into the earth.

Second, in economic terms, calculating net benefits of these technologies is quite difficult. On the cost side, one must factor in the net increase in labor requirements of hauling manure, water, and crop byproducts and wastes (and these are largely a function of distances among stables or corrals and wells and fields), and then compare these to the net increase in fertilizer quality and quantity produced (as compared to traditional organic or conventional inorganic fertilizing methods) and to the influence on yields. Then, it is necessary to make assumptions about the increased sustainability of these new fertilization techniques versus traditional or conventional ones over time. The time and

[40] Considerable research and extension attention has been given to a promising variety of an early-maturing, high-yielding cowpea (TN8863) that may get around this constraint.

labor implications of all this hauling do not appear to have not been fully factored in by research and extension.[41] The OHVN SMS for animal agriculture recounted one Gouani farmer's report of how, in his first year of experimentation with an improved corral for his 180 head of cattle, he made well over 100 trips with his donkey cart in order to transport some 50 metric tons of organic fertilizer to his cotton fields.[42] Offhand, it would seem that only households with access to ample labor and transport could make use of these techniques on any appreciable scale. On the benefit side, measuring incremental improvements in the quality of manure (as well as getting valid estimates of increases in quantities generated), and determining application levels is very difficult to do in field trials.

With regard to the fodder crop, *doliki*, in agroecological terms, it is also hard to determine incremental soil fertility benefits over traditional crops such as groundnut and cowpea. In economic terms, however, studies in other parts of semi-arid Africa indicate that it is less cost-effective than its traditional counterparts, groundnut and cowpea (McIntire et al. 1992). In any case, research Africa-wide on the returns to labor of sown forages does not bode well for *doliki* adoption outside areas with specialized markets for the products of feeder or dairy animals.

Third, how would these techniques fit into current farming systems? Would increased labor requirements conflict with any seasonal bottlenecks? What are the pros and cons of doing some of this work collectively versus individually? What are the gender implications of these interventions? Because cart and, in most cases, animal ownership is a prerequisite to adopting these technologies, are there other soil fertility-enhancing technologies that could be extended to farmers without access to carts and significant livestock resources? For *doliki*, this is a particularly complicated question due to differences in rainfall regimes, cropping calendars, household economic portfolios, market access, and so forth in the southern and the northern OHVN.

Indeed, the experience with *doliki* research and extension suggests that greater care is required in gauging the fit -- both agroecologically and socioeconomically -- of proposed interventions. There seems to be a danger of making blanket research and extension recommendations for north and south, for labor-rich and -poor, for producers near to and far from large urban markets, and so forth. Also, inadequate attention has been given to land use and tenure considerations. A corollary lesson is that better mechanisms to get farmer feedback "back" through the research-extension system are needed. Although definitive statements can not yet be advanced, it would appear that *doliki* has more promise in the north than in the south. At the very least, it is evident that the nature of constraints to adoption differ significantly between the two regions.

Case Study: Adoption of Maize Varieties[43]

This section examines the performance of several Malian institutions in developing and extending improved maize cropping technology in Southern Mali. A number of these institutions were partially supported by A.I.D. financing, and it will be argued that this support, although not large in dollar

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[41] Christophersen (1988:15) offers some labor assumptions for compost pits in the OHVN zone, but they seem unrealistically low. For a greater appreciation of the complexities involved, see McIntire et al. (1992).

[42] OHVN advises farmers to apply 5-10 tons/ha to millet and sorghum, and 10-20 tons/ha to maize and cotton (Shaikh et al 1988:14).

[43] Information in this section borrows heavily from Boughton and Henri de Frahan (1992).

terms, was essential for technologies to be developed to the point that they were ready for extension to farmers.

Such technologies are relevant to sustainable agriculture because they lessened the need for pesticides (as the varieties promoted were streak-resistant), contributed to more efficient use of chemical fertilizers (due to spillover effects from cotton complex fertilizers), and ultimately strengthened the economic sustainability of cotton-based cropping systems by their contribution to farm household food security. The case study highlights the benefits of regional and international cooperation in research, and how it can result in more cost-effective development of technologies for a small country such as Mali with limited financial resources and scarce human capital.

Research in Mali on maize began in 1964, and was mainly carried out by IRAT. Resources devoted to maize research were limited, and it was never really a top priority, reflecting the minor economic importance of the crop relative to cotton, rice, and other coarse grains. Up until about 1980, research was largely confined to varietal improvement and some fertilizer response trials. Early work involved crossing US and Israeli exotics with the local high yielding variety, Tiémantié de Zamblara. In the 1970s, IRAT concentrated on a West African regional strategy for crossing varieties. Collaboration was close with IRAT researchers in Burkina and Cote d'Ivoire on combining local ecotypes. Unfortunately, however, none of the crosses out-performed Tiementie, which was not only high-yielding, but exhibited more stable yields as well.

In 1979, improved composite materials arrived from CIMMYT. This was welcome because of the disappointing results in the 1970s; but the Malian maize program remained hampered by lack of funding. Yet two developments set the stage for a possible take-off of maize technology in the 1980s. First, regional research carried out by IITA (and partially assisted by A.I.D.'s SAFGRAD project) on maize cropping systems using the CIMMYT genetic materials emphasized early maturity. There were also potential spillover benefits from more ambitious programs that had been going on for a number of years in other West African countries. In Côte d'Ivoire, Burkina Faso, Benin, Senegal, and Togo, substantial effort was devoted to research on cultivation techniques including: soil and seedbed preparation techniques; planting dates and densities; and crop rotations. The coming together of these efforts formed the basis to begin constituting elements of technical packages for maize cropping systems by the early 1980s.

In 1980, an integrated approach to research in Mali began with testing of maize-based intercroppping systems on-station by ICRISAT and local scientists (in collaboration with the regional IITA maize program). On-farm research was subsequently carried out by SAFGRAD and FSR teams with the IER based in Sikasso and Bougouni in the CMDT zone, and Sotuba in the OHVN zone.

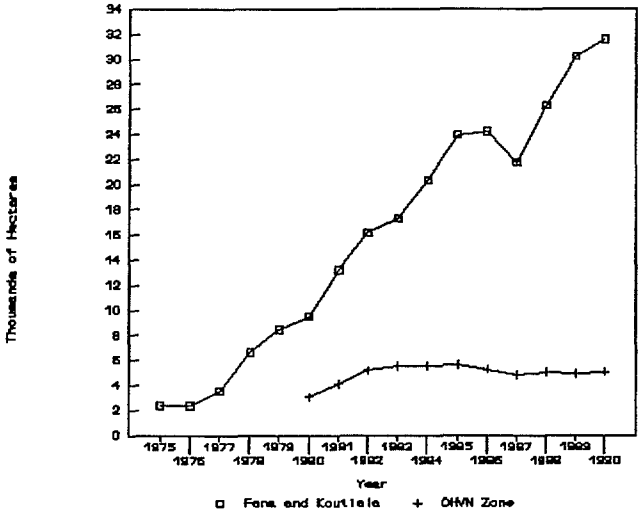
Early farmer surveys indicated that emphasis on early maturity should receive highest priority. This was the case for the central and western sections of the country due to declining rainfall levels and for Southern Mali because early harvest of maize would be a major contribution to improved food security during the lean season (*soudure*).

The catalyst for a major push on maize research came in the form of a serious outbreak of the streak virus in 1983 in the CMDT zone. This led to tight collaboration between the CMDT and the IER maize program that exists to this day. In just four years, IER released TZESR-W, an improved variety that had been exchanged through the regional maize network in West Africa. Although chosen primarily for streak resistance, TZESR-W is especially appreciated by farmers for early

maturity and its ability to perform well with limited doses of fertilizer -- characteristics that became especially important after guaranteed producer prices for maize were withdrawn in 1986 and fertilizer subsidies were abolished as part of the market liberalization program of the mid-1980s.

In addition to TZESR-W, several other maize varieties that came through the regional network have been released. These include SAFITA-2, Golden Crystal, TZPB-SR, and TZEF-Y.[44] Yet unfortunately, research alone has not been sufficient to realize the full potential of these technologies in farmers' fields. With the exception of the CMDT zone, adoption has been severely hampered by a lack of seed multiplication and delivery systems, and effective extension. Figure 4-1[45] illustrates trends in area devoted to improved maize varieties in the CMDT and OHVN zones. The Fana and Koutiala sectors of the CMDT zone are chosen because, agronomically, they are most similar to the southern part of the OHVN zone. Despite the agronomic suitability of maize to the southern part of the OHVN zone, the contrast between adoption in the two areas is stark. Between 1975 and 1990, the pace of improved variety adoption was dramatic in the two CMDT sectors while it was rather phlegmatic in the OHVN zone.[46]

Figure 4-1
Area Planted to Improved Maize Varieties: Fana, Koutiala, and OHVN Zone, 1975 - 1989



The specific reasons for the CMDT zone success in maize technology dissemination were that: the zone is highly mechanized due to the long cotton history; the residual effect of fertilizer application to cotton in one year on maize the next year aids yields substantially; and the launching of French maize extension program (Projet Mais) in 1980 sped adoption. Rapid adoption was also facilitated by the GRM policy of a guaranteed floor price for maize in the first half of the 1980s. Yet this was not specific to the CMDT zone and OHVN producers could also have taken advantage of it if they chose to do so. The guaranteed price was abolished in 1986 because falling cereals prices made it financially unsustainable for the GRM. Yet interestingly, CMDT zone area planted to improved maize varieties continued to expand rapidly in the latter half of the 1980s.

[44] Sanders, John H., Bezuneh, Taye, and Schroeder, Alan C., "Impact Assessment of the SAFGRAD Commodity Networks," prepared for USAID/AFR/OAU/STRC-SAFGRAD. May 1993.

[45] Data for this figure is from Duncan Boughton of IER.

[46] In the overall CMDT zone, area planted to improved maize varieties rose from 20,119 hectares in 1980 to 75,509 hectares in 1990. In the OHVN zone, this figure rose from 3,044 hectares to 5,063 hectares over the same period (Boughton and Henri de Frahan, 1992).

At a more general level and taking a longer-term perspective, the difference in performance is primarily attributable to the fact that complimentary investments in human and physical capital were in place in the CMDT zone in the early and mid-1980s, while largely absent from the OHVN zone during the same time period. Writing in 1989, Dione asserts that CMDT performance has been generally superior for the following reasons:

- There is a higher degree of farmer participation in local decision-making because most marketing functions had already been transferred to village associations;

- Linkages with the international CFDT network facilitates technology transfer between West African countries;

- After dissolution of the Malian parastatal charged with providing agricultural credit, and serving as an input and equipment supplier (SCAER), CMDT became the only RDO with direct access to credit; and

- Due to the fact that it has more resources at its disposal, strong management, and a much longer track record, the CMDT has developed a far stronger extension service than exists in the OHVN zone.

As has been stated elsewhere in this paper, it is important to point out that major changes have occurred in the OHVN zone since Dione wrote in 1989. Remarkable progress has been made at transferring responsibilities to village associations. The shift towards direct negotiation between village associations and banks makes credit availability less of a constraint in the southern OHVN zone than was the case several years ago. However, Bingen et al (1992) cast serious doubt on the question of whether OHVN has made any real strides towards becoming a more professional and capable extension service. Moreover, there has only been further deterioration of the financial situation of OHVN, as its commercial functions are gradually shifted to village associations and the private sector.

Among the lessons that can be gleaned from this case study is that a string of conditions from research to extension to village-level organizational development need to be in place if promising new technologies are to have a major impact on sustainable agricultural development.

At the level of research, spillover effects from international and regional networking can greatly increase the cost-effectiveness at the national level. The rapid introduction of improved maize varieties that responded to local preferences (i.e. early maturity and disease resistance) would not have been possible without the sustained longer-term commitment to research at the regional (IRAT and IITA through SAFGRAD) and international (CIMMYT and ICRISAT) levels. Boughton and Henri de Frahan (1992) estimate the internal rate of return for Malian maize research and extension at 135 percent. This is a dramatic quantification of the potential spillover benefits on national programs of international agricultural research networking.

From an A.I.D. perspective, lessons regarding extension are less heartening. Extension proved to be the weak link in the chain from research to village level organizations. While extension fully exploited the opportunities presented by the new maize varieties in the CMDT zone, efforts in the OHVN zone have fallen far short of the mark. Villagers are (vaguely) aware of the existence of new varieties; however at this point in time availability is the binding constraint. From an institutional

perspective, OHVN does not appear to have any compelling incentive to promote food crops, as long as public funding is not assured for its survival, and the only profit-making operations it has are cotton and (to a lesser extent) tobacco.

OHVN's failure to pick up on promising new varieties is especially worrying when one considers the following: where farmer trust and confidence in extension services has actually developed, the primary initial impetus has often come from the distribution of new varieties that clearly outperformed traditional varieties. It is usually fairly easy to convince farmers to accept these as they do not involve additional labor or substantial sums of capital, only substitution of traditional varieties with new ones. An extension service armed with a new variety has a major opportunity to increase its credibility, and this can facilitate adoption of other technologies and practices (such as cultural practices and natural resource management techniques) that usually present more problems for farmer acceptance.

5. FINDINGS, LESSONS LEARNED, AND FUTURE IMPLICATIONS

This final chapter begins by summarizing the most important findings related to A.I.D.'s experience in promoting sustainable agriculture interventions in Mali. It then highlights lessons learned with possible applicability for similar interventions in other countries. Finally it discusses implications for future interventions, organized around the areas of replicability, sustainability, efficiency, effectiveness, and impacts.

Summary of Findings

The OHVN roads component. The A.I.D.-funded rural and farm-to-market roads were a precondition to all else that has been achieved. Since the advent of A.I.D. support in the OHVN zone, nearly 600 km of roads have been constructed and maintained. Yet a major challenge remains in identifying a plan for sustainable road maintenance based on giving increased responsibility to local populations.

Development of village-level organizations. The A.I.D.-funded CLUSA process in the OHVN zone has rapidly and effectively empowered rural people to become the "engine of their own development." The success of these interventions were greatly facilitated by GRM policy initiatives in decentralization and the encouragement of local-level cooperative organization, coupled with the A.I.D.-induced OHVN restructuring. Consequently, village associations have taken on responsibility for:

- obtaining and responsibly managing group credit from commercial banks (stimulated by A.I.D. policy work and initial guarantee funds);
- negotiating the quantity, purchase price, and delivery of agricultural inputs themselves;
- making their own choices about the use of inputs vis-a-vis crop mix;
- engaging more directly in the product marketing process;
- assisting in the maintenance of rural and farm-to-market roads;
- serving as the base-level of the agricultural extension service; and
- directing and delivering their own functional literacy training.

That said, the foundations of these developments remain extremely fragile, as they are largely based on cotton markets and the continued motivation of a small number of overworked and underpaid village animateurs.

The OHVN focus. Efforts to focus OHVN exclusively on agricultural extension (and gradually shifting responsibility for credit, input and output marketing elsewhere) and increase the professionalism of OHVN extension services represent a step in the right direction. At the same time, OHV's capacity or motivation for extending non-cotton-related NRM techniques is questionable. A telling case is its failure to extend improved early-maturing, streak-resistant open-pollinated maize

varieties generated by research during the 1980s. This stands in stark contrast to the successful and widespread dissemination of these varieties in the CMDT zone.

Moreover, the DHV Project risks losing its principal, long-term focus on improving OHVN capacity to do extension by introducing new project components (i.e. non-traditional export promotion) for which OHVN has no comparative advantage. Nor is it terribly clear that OHVN has much internal interest in introducing this activity or sense of "ownership." This risks a return to the inchoate and unmanageable design that pertained under the predecessor OHV Project -- a situation which, since 1988, DHV has labored to correct.

Adaptive research and technology dissemination. Both in terms of regional "spillover" effects and in terms of adaptive research in Mali, technology development has wisely drawn from and built upon the local NRM knowledge base, with the result that farmers appear to more readily accept the "new" NRM messages. In addition, although much remains to be done, the DHV Project has made immense strides in establishing the basic preconditions for women to participate in and benefit from NRM development, both economically and educationally.

However, OHVN appears to have made little progress in clarifying extension messages, differentiating them by agro-ecological zone or socio-economic group, or developing mechanisms for soliciting feedback from farmers on the suitability of the NRM technologies and practices extended by OHV. In particular, the research-extension link is weak.

In addition, FSR&E project performance has suffered from frequent technical assistance turnover and from advisors being spread too thinly across the two FSR teams supported by A.I.D. This has delayed development of new technologies and monitoring of existing ones for their appropriateness to farm-level conditions in this very heterogeneous zone.

Functional literacy. While major achievements have been made in extending functional literacy in the project zone, according to farmer and other reports, progress on this front seems to have slowed. This risks compromising the sustainability of efforts made to strengthen village-level organizations. Also, the question arises: to what extent should an agricultural extension agency be responsible for fulfilling basic education needs?

Lessons Learned

The effectiveness of sustainable agriculture interventions is not only the result of choice of technology; issues of policy, sociology, human and infrastructural capital investment, and empowerment are also important. In the case of Mali, achievement of success in adoption of sustainable agriculture technologies was the result of a number of factors coming together, including: a strong functional literacy base; liberalized markets; a public commitment to democratization and local-level empowerment; access to high-quality training in financial management and organizational skills; and ready access to markets. Active involvement of the commercial banking sector is especially noteworthy. Although it is rare for commercial banks to show interest in extending credit to small farmers, they have taken on an active role in lending to small farmers at market interest rates. Their involvement is predicated on the following conditions: lending is to groups with "solidarity" as collateral; evidence exists of rudimentary financial management capabilities (as evidenced by CLUSA training); and a reliable cash crop (cotton) is used as the basis for lending. The relative success of improved maize varieties in the CMDT versus the OHVN zones suggests that a

long history of public investment in infrastructure and delivery systems makes it easier for farmers to take advantage of promising new NRM technologies. This finding implies that, to the extent that the OHVN program of road construction and maintenance matures and the OHVN new extension structure stabilizes and professionalizes (and to the extent that the foregoing five conditions are met), A.I.D. can expect greater returns to its investments in sustainable cropland management.

Synergisms among A.I.D.-supported regional and national research programs (CIMMYT, IITA, ICRISAT, SAFGRAD, FSR&E) and regional extension organizations (CMDT, OHVN) appear to increase the chances of the elaboration of appropriate NRM technology, and hence adoption. This is amply demonstrated in the cases of maize and *doliki* where the spillover effects of regional research hastened the adaptation of these technologies to local conditions. As the case of *doliki* in the southern OHVN also indicates, farmers will adopt environmentally sound and sustainable cropland technologies only insofar as these are tailored (and correctly communicated) to fit local agroecological and socioeconomic circumstance. Comparing the maize story with the other cases, a corollory of this finding is that cultural and management practices -- which often must be tightly tailored to site-specific conditions -- are generally more difficult to codify and extend than technology in the handy form of seeds.

Technologies that seem most widely adopted are those for which farmers can readily observe or identify a short-run payoff. Examples are rock lines or other, simple soil-conservation structures that visibly arrest erosion in fields that have already suffered serious damage; organic fertilizers and disease- or pest-resistant cultivars, which save on farmer expenditures for agrochemicals; and where there are ready urban markets for livestock products, cultivated forages that are cheaper than purchased agro-industrial byproducts (as with cottonseed cake and the Banamba women's co-op). Related to this finding is the observation that producers must first recognize a natural resource problem as serious before they are willing to take ameliorative steps -- as longtime mechanized cotton-growers with few land-expansion options are now becoming more aware of soil fertility losses in their croplands.

Some temporary subsidy or incentive programs may be necessary if it is clear that farmers are unable to adopt natural resource conservation practices "until it is too late." To some extent, this is a corollary of the lesson above. However, care must be taken to avoid the tendency to give out "gifts." This may be the case for truck rental to haul construction materials for largescale soil-and-water control installations, or possibly for seed multiplication of alien cultivars like *doliki*.

Cultivars, technologies, or land-use practices that have a strong cognate in local cropping systems and practices stand a better chance of adoption than alien ones. Hence the relative success of such interventions as a new variety of an already-common cultivar (maize); improvements on soil-and-water conservation and control installations (more accurate contouring and tiering of rock lines) that are already regionally or locally familiar to producers; or enhancement and intensification of a universal, indigenous strategy of nutrient recycling (use of organic fertilizers). More difficult will be interventions such as *doliki* -- where a soil-restoring but alien cultivar is to be introduced in farming systems with limited or no tradition of raising crops primarily for forage, fallow cover, or haying, and where existing land tenure regimes are therefore ill-adapted to accommodate such shifts in cropland management.[47]

[47] The complexities of introducing such crops to sub-Saharan Africa are well-known and studied (cf. McIntire et al. 1992).

Replicability

It is a basic premise of this report that development of strong village-level organizations is a fundamental prerequisite for sustainable agricultural development. These organizations can serve as the critical interface between research and extension agencies on technology adoption, provided that these official agencies have useful information and services to offer to farmers. To date, the greatest (and most potentially sustainable) success of A.I.D. support to farmers in the OHVN zone has been in the area of village-level organization. To assess the potential replicability of the training undertaken by CLUSA, a number of factors were major contributors. Without them, the effectiveness of CLUSA training would probably be diluted. These include the following:

- A long history of functional literacy development in Mali;

- Market liberalization: free entry of private merchants in selected input and output markets (both domestic and international for imported inputs especially). If a parastatal like SCAER still maintained an official monopoly on input distribution, the freedom to negotiate with input suppliers would not exist, and village associations would therefore have little incentive to participate in the CLUSA program;

- Recent political developments on democratization and local-level empowerment. Subsumed here is the fact that there is a long history of cooperative development in Mali, and village associations have the freedom to form with members of their own choosing -- more of a grassroots phenomena than in many other African countries where cooperative development is top-down and coops are pseudo-state institutions;

- Existence of a strong cash crop (cotton) that makes bankers more comfortable, and gives farmers a strong incentive to demand purchased inputs;

- Tied to this, access to formal agricultural credit through banks -- important because agricultural credit has collapsed in much of the rest of Africa. As with market liberalization above, this implies the absence of a parastatal like SCAER which would effectively limit access to credit;

- Availability of high-quality training in financial management and organizational skills through highly-motivated CLUSA agents. One could also argue that because CLUSA agents are not civil servants this increases motivation as salary levels are more attractive and CLUSA has more flexibility to recruit appropriate personnel;

- Access to markets and presence of physical infrastructure, including good roads: closeness of Bamako, assured marketing outlet for cotton;

With regard to adoption of NRM and sustainable agriculture technologies, it is more difficult to discuss replicability. This is because reliable information on the extent of technology adoption (as well as profiles of who has adopted and why) is lacking, and the economic viability of many technologies within the context of existing farming systems remains to be firmly established. Adaptive research-extension linkages remain weak in the OHVN zone, and these are weakest when it comes to monitoring of feedback from farmers on the appropriateness of technologies.

Sustainability

A number of developments point to the potential sustainability of village-level activities and sustainable agriculture technology adoption. Functional literacy and rudimentary management training greatly facilitates farmer decision-making on negotiating credit with banks and prices and terms of input delivery with suppliers. Farmers are clearly taking the initiative to make decisions that were imposed upon them by government in the past. Empowerment of this sort is not something they will easily give up. This is a political issue as well as an economic one: in other words, one can speak of "political sustainability" as well as economic or financial sustainability. In this sense, this new phenomenon of empowerment has the potential to survive after donors have pulled out. Farmers will not easily return decision-making powers to government. At the same time, several developments serve to signal the potential vulnerability of current accomplishments, including:

- Continued poor prospects of world cotton prices. This could make it less attractive for farmers to invest in cash-cropping and riskier for bankers to provide production and investment credit;

- Inability so far to come up with a viable plan for road maintenance in the OHVN zone;

- Problems for the GRM to meet recurrent costs of IER and OHVN. This could seriously compromise generation of new sustainable agriculture technologies and continued dissemination of existing ones;

- Problems for the GRM to meet recurrent costs of DNAFLA and questions from some quarters about DNAFLA's performance to date;

- Related to this, is the intense pressure/overworking of the existing pool of village-level animateurs with minimal (or nonexistent) remuneration. Not only does this problem need to be addressed (ultimately by villagers, with government and donors limiting themselves to a facilitating role), but it is fundamental that a hard look be taken at the question of whether the next generation of animateurs is being developed.

Efficiency

These relate largely to economic incentives to adopt, and include:

- Dominance of cotton in Southern Mali introduces a complex set of dynamics. On the one hand, cotton production is strongly correlated with increased access to and use of animal traction equipment and chemical fertilizers, and land extensification. In isolation, these lead to important yield and production gains in the short-run, but also to accelerated medium and long-term depletion of soil fertility. Yet these developments may also increase incentives to adopt complementary NRM technologies, assuming they are appropriate to local conditions and are effectively disseminated to farmers. Often farmers do not perceive the need for NRM technologies until land is seriously degraded. The challenge for research and extension is not only to develop and extend technologies to those with seriously depleted soils, but to also convince those not yet severely affected to adopt.

- Incentives to adopt sustainable NRM technologies are perhaps stronger now than ever before. This is because farmers are increasingly aware of losses in soil productivity and problems of

water and wind erosion. At the same time, higher prices for chemical fertilizers, combined with lower farm output prices have pushed farmers to search for alternative (non-purchased) inputs for maintaining soil fertility such as organic fertilizers. That said, measuring the extent of adoption remains a problem.

- Those technologies that seem most widely adopted are those with a readily observable short-run pay-off (as well as any longer term ones). Extension strategies need to incorporate more thought about sequencing of messages and would be well-advised to start with these ones first, before going to others where benefits are less readily observable in the short-run. Good examples of interventions with observable short-run pay-offs are: construction of rock lines in seriously eroded fields; and improved seed varieties that promote more environmentally and economically sustainable farming systems and contribute to food security;

- Related to this is the following: both in terms of regional "spillover" effects and in terms of adaptive research in Mali, technology development has wisely drawn from and built upon the local NRM knowledge base, with the result that farmers appear to more readily accept the "new" NRM messages.

- That said, there may be ways to stimulate greater adoption through temporary subsidy programs. Providing resources for truck rental to construct rock lines is one example (with the caveat that this is not a simple short-cut to adoption: effective dissemination (*sensibilisation*) must still take place to convince farmers, and local contributions in the form of labor and cash must still be substantial. Another example is provision of a (temporary) guaranteed market for output as was the case for accelerating adoption of improved maize varieties in the early 1980s. However, this is far more problematic. At a minimum, extension agencies must consider the marketing implications of any new crops they promote (as OHVN apparently did not do in the case of sesame in the northern OHVN zone);

- Calculating the economic net benefits of crop/livestock integration technologies is difficult in a real world setting and there are doubts about the feasibility of adoption on any appreciable scale due to labor and cash requirements. A fair amount of research remains to be done to generate technologies properly differentiated by recommendation domain.

Effectiveness

These relate largely to the impact on equity of interventions, and include:

- Greater emphasis needs to be put on differentiating technologies by geography and by levels of resource endowments of farmers. While the vast majority of these farmers can be classified as semi-subsistence farmers (as opposed to purely commercial farmers), there is still a great deal of heterogeneity in the level of resources available to them. This is both a question of equity and efficiency. Initially, this is an issue for research. However, once at the pre-extension or extension stage, communication from research to extension, and from extension to farmers should be more systematic (in the form of better-tailored training sessions for agents and animateurs and more careful preparation of *fiches techniques*). Introduction of dolique is an example of a technology that may be very appropriate for certain parts of the OHVN zone (those with less rainfall, and where livestock has greater economic importance). Better targeting of technologies based on farmer endowments could be done for the various types of organic fertilizer

recommendations. Research needs to sort through the wide array of current possible options and determine which are more appropriate for different farm-types.

- While assistance to local organizations has been largely successful at increasing management and decision-making capacities, concerns have been raised about who within village associations receive the benefits of cooperative development. Are benefits within villages truly broad-based, or are they largely captured by a handful of the relatively better-off? CLUSA should be lauded for raising this issue (without prompting from critics) and attempting to deal with it by working with village groups. However, the issue deserves more careful study in the future.

- The DHV Project has made major strides in establishing the basic preconditions for women to participate in and benefit from sustainable agricultural development, both economically and educationally.

Impacts

It is difficult to make definitive statements about the impacts of A.I.D.-supported activities for a number of reasons. First, although anecdotal evidence abounds, little confidence can currently be placed in existing adoption rate data. Obviously, before one can determine biophysical or socio-economic impact of introduction of a given technology, one must have a good sense of the extent of adoption, as well as any variations on adoption that have occurred. Technology "packages" are rarely adopted in full, nor is the nature of adoption immutable. Rather it changes as a function of shifting economic conditions and perceived changes in the physical environment. By and large, adoption rate studies in the project zone have not taken this point of view. Rather they have tended to be simple "counting-up" exercises. Secondly, as those technologies that appear to be most popular are often minor variations on existing technologies, it can be difficult to detect what is a change introduced by extension, and what is simply "business as usual." This calls for intimate knowledge of existing farming systems, differentiated by agro-ecological zone. The "counting-up" approach lends no clarity here as what might be a "new" technology in one project sub-zone is actually a traditional technology in another sub-zone!

Adoption of streak-resistant maize varieties. Through various regional projects, A.I.D. supported the highly successful introduction of streak-resistant maize varieties in Southern Mali. The most obvious benefit of these new varieties was maintenance and improvement of existing yield levels. In addition, food security (a socio-economic impact) was improved because these varieties were also early maturing. In addition, these varieties lessened dependance on pesticides. This had two impacts: a positive bio-physical impact because of potential negative environmental (and health) impacts associated with pesticide use; and a positive economic impact because of avoidance of financial costs associated with purchasing pesticides.

Possible impacts on out-migration. Although hard data are scarce, there are anecdotal signs that the rural exodus has begun to slow, and even reverse itself. This is probably attributable to a number of factors, including: road construction and increased agricultural income-earning opportunities in the project zone; expansion of cotton production; empowerment and increased access to credit resulting from DHV activities; and worsening economic conditions in adjacent countries (Senegal and Côte d'Ivoire) have made seasonal out-migration less attractive than was the case in the past. Further study is required on demographic trends before any definitive statements can be made on migration patterns and their determinants in the OHVN zone.

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ANNEX A: DATA FOR CALCULATION OF COSTS AND BENEFITS OF ROCK LINE INSTALLATION WITH ALTERNATIVE MODES OF TRANSPORT

Table A-1: Typical Farm Budgets in OHVN Zones

Northern Zone:

	Units	Millet	Sorghum	Sesame	Farm Total	Zone Total
Area Cultivated	ha	1.456	0.861	0.019	2.34	69,572
Yield/ha	Kg	600.0	800.0	600.0		
Crop Price	CFA/kg	50.0	50.0	50.0		
Revenue	CFA/farm	30,000	40,000	30,000	100,000	

Middle Zone:

	Units	Millet	Sorghum	Maize	Cotton	Tobacco	Groundnuts	Total	Total
Area Cultivated	ha	0.846	1.324	0.299	0.399	0.056	0.261	3.185	56,058
Yield/ha	Kg	728.0	940.0	2,040.0	1,380.0	2,000.0	896.3		
Crop Price	CFA/kg	50.0	50.0	50.0	84.7	286.9	160.0		
Revenue	CFA/farm	36,400	47,000	102,000	116,886	573,800	143,400	*********	

Southern Zone:

	Units	Millet	Sorghum	Maize	Rice	Cotton	Tobacco	Groundnuts	Vegetables	Farm Total	Zone Total
Area Cultivated	ha	0.565	1.495	0.548	0.311	0.483	0.076	0.675	0.381	4.53	58,982
Yield/ha	Kg	792.0	940.0	2,040.0	820.0	1,242.0	1,400.0	896.3	6,000.0		
Crop Price	CFA/kg	50.0	50.0	50.0	70	84.7	286.9	160.0	100.0		
Revenue	CFA/farm	39,600	47,000	102,000	57,400	105,197	401,660	143,400	600,000	1,496,257	

Source: Spreadsheets provided by Vic Duarte, Mission Economist, A.I.D./Mali.

Table A-2: Cost and Benefit Streams for 5 hectares

	Base Case Revenues (no erosion)			% Yield Reduction		Incremental Revenues			Total	Costs			Net Benefits		
Year	North	Middle	South	Without	With	North	Middle	South	(Average)	Truck	Cart	Manual	Truck	Cart	Manual
1	214,091	1,600,348	1,650,130	10.0%	10.0%	0	0	0	0	112,962	139,419	212,199	(112,962)	(139,419)	(212,199)
2	214,091	1,600,348	1,650,130	20.0%	10.0%	21,409	160,035	165,013	115,486	1,000	1,000	1,000	114,486	114,486	114,486
3	214,091	1,600,348	1,650,130	20.0%	10.0%	21,409	160,035	165,013	115,486	1,000	1,000	1,000	114,486	114,486	114,486
4	214,091	1,600,348	1,650,130	20.0%	10.0%	21,409	160,035	165,013	115,486	1,000	1,000	1,000	114,486	114,486	114,486
5	214,091	1,600,348	1,650,130	20.0%	10.0%	21,409	160,035	165,013	115,486	1,000	1,000	1,000	114,486	114,486	114,486
6	0	0	0	20.0%	10.0%	0	0	0	0	0	0	0	0	0	0
7	0	0	0	20.0%	10.0%	0	0	0	0	0	0	0	0	0	0
8	0	0	0	20.0%	10.0%	0	0	0	0	0	0	0	0	0	0
9	214,091	1,600,348	1,650,130	20.0%	10.0%	21,409	160,035	165,013	115,486	2,000	2,000	2,000	113,486	113,486	113,486
10	214,091	1,600,348	1,650,130	20.0%	10.0%	21,409	160,035	165,013	115,486	1,000	1,000	1,000	114,486	114,486	114,486
11	214,091	1,600,348	1,650,130	20.0%	10.0%	21,409	160,035	165,013	115,486	1,000	1,000	1,000	114,486	114,486	114,486
12	214,091	1,600,348	1,650,130	20.0%	10.0%	21,409	160,035	165,013	115,486	1,000	1,000	1,000	114,486	114,486	114,486
13	214,091	1,600,348	1,650,130	20.0%	10.0%	21,409	160,035	165,013	115,486	1,000	1,000	1,000	114,486	114,486	114,486
14	0	0	0	20.0%	10.0%	0	0	0	0	0	0	0	0	0	0
15	0	0	0	20.0%	10.0%	0	0	0	0	0	0	0	0	0	0
16	0	0	0	20.0%	10.0%	0	0	0	0	0	0	0	0	0	0
17	214,091	1,600,348	1,650,130	20.0%	10.0%	21,409	160,035	165,013	115,486	2,000	2,000	2,000	113,486	113,486	113,486
18	214,091	1,600,348	1,650,130	20.0%	10.0%	21,409	160,035	165,013	115,486	1,000	1,000	1,000	114,486	114,486	114,486
19	214,091	1,600,348	1,650,130	20.0%	10.0%	21,409	160,035	165,013	115,486	1,000	1,000	1,000	114,486	114,486	114,486
20	214,091	1,600,348	1,650,130	20.0%	10.0%	21,409	160,035	165,013	115,486	1,000	1,000	1,000	114,486	114,486	114,486
												IRR	95.3%	74.9%	45.3%
												Disc. Rat	20.0%	20.0%	20.0%
												NPV	248,261	226,214	165,564

ANNEX B: CONTACTS LIST

A.I.D./Washington
Barnes, Carolyn -- CDIE/E/SPS PRISM WID Specialist
Cashion, Jerry --AFR/EA (Former A.I.D./Mali Evaluation Officer)
Conly, Jock -- POL/CDIE/E/POA, Division Chief
Church, Phil -- CDIE
Darkins, William -- AFR/SWA Mali Country Officer and Acting Deputy Office Director
McGahey, Michael -- AFR/ARTS/FARA, Agriculture/NaturalResources Officer
Mitchell, Marion -- FEWS Project Field Coordinator and Social Scientist (703/243-1070)
Olson, Craig -- CDIE ETS Contract Project Manager (DAI)
Pryor, Anthony -- AFR/ARTS/FARA, Agr/Nat Resources Economist
Sowers, Fred -- CDIE
Wisler, Carl -- CDIE ETS Contract Evaluation Specialist (DAI)
Young, Mary -- CDIE ETS Contract Natural Resources Specialist (RTI)

APEX Project
Cook, Dick -- Chief of Party

CLUSA/Bamako
Ag Akeratane, Mohammed -- Technical Assistant, Sociology/Pedagogy
Djire, Abderhamane -- Technical Assistant, Livestock
Felton, Jeff -- Technical Assistant, Small Businesses
Guindo-Sidibe, Fatoumata -- Technical Assistant, WID

CLUSA/Outside Bamako
Diabate, Fousseyni -- Assistant, Ouelessebougou Secteur
Niambele, Yacouba -- Assistant, Banamba Secteur

DNAFLA/Bamako
Sanogo, Mariam -- Computer Operator/Publications

DNAFLA/Outside Bamako
Traore, Ousman -- Chef de ZAF, Ouelessebougou Secteur

DRSPR (FSR)/Mopti
Dr. Berthe, Abou

DRSPR (FSR)/Sikasso
Bengaly, Mpie -- Agronomist
Bosma, Poel -- Veterinary Scientist
Coulibaly, Ngole -- Sociologist
Defoer, Toon -- Agronomist, Royal Tropical Institute (KIT) Chief of Party
Hilhorst, Thea -- Sociologist
Kamara, Abdooulaye -- Agronomist
Kaya, Bocary -- Land Use Planner

DRSPR (FSR)/Sotuba
Fofana, Makan -- Chef de DRSPR/Soutuba (pas encore vu)
Oumou-Diallo, Mariko -- Agronomist and Computer Specialist
Kalilou, Tigana -- Agronomist and Computer Specialist
Khibe, Torade -- Coordinator, DRSPR Soutuba
Yeboah, Anthony -- SECID Chief of Party

IER/Bamako
Boughton, Duncan -- Agricultural Economist, DPAER
Diambele, Lassine -- Directeur General Adjoint and Seed Specialist
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Ministere du Developpement Rural (MDRE)/Bamako
Boré, M. -- PNVA
Dembele, Brahima -- Seed Multiplication Project
Nkikabahizi, Pasteur -- Seed Multiplication Project
Toll, Oumar -- Conseiller Technique
Traore, Moussa D. -- Directeur de Cabinet

MDRE/Outside Bamako
Sogodogo, Lacina -- Livestock Agent, Banamba

OHVN/Bamako
Berthe, Salikou -- SMS for Animal Agriculture
Coulibaly, Amadou -- Chef de Statistique et Evaluation
Coulibaly, Seydou -- Chef de Vulgarisation and Ag Engineer
Djakite, Noumoutie -- Chef de Production (or Protection?) Vegetal et Animal
Goundamkoye, Abdrahamann -- Sector Chief, Ouelesseboubou
Kanouté, Sidi -- Chef, DIL
Keita, Nambala -- Chef de Credit
Makone, Mah Diallo -- WID Specialist for Ag Extension
Sanogo, Salikou -- Specialiste Agronome, Division de Vulgarisation
Sidibe, Cheickne -- Chief, Extension Section
Togola, Yaya -- Directeur General
Traore, Assan -- WID Credit Specialist

OHVN/Outside Bamako
Coulibaly, Bakari -- Chef de Sous-Secteur, Sugula
Coulibaly, Salimata -- Animatrice de Secteur, Banamba Secteur
Djiarra, Lassine -- Chef de Sous-Secteur, Ouelessebougou Secteur
Keita, Namambilie -- Chef de Sous-Secteur, Banamba Secteur
Soumaoro, N'Famoussa -- Chef Secteur Adjoint, Banamba
Togolar, Drissa -- Agent de Credit, Sugula

Policy Reform for Economic Development Project
Girma, Wolde-Mariam -- Chief of Party

A.I.D./Bamako

Bilodeau, Dennis -- ADO, OHVN Project Officer
Camara, Amadou -- ADO, Agricultural Economist
Dagamaissa, Abdoulaye -- ADO, Village Reforestation Project Manager
Dembele, Augustin -- ADO, Farming Systems Research Project
Diallo, Amadou -- ADO/OHVN, Literacy and Village Associations
Drame, Cheick -- APEX Project Officer and Livestock Specialist
Duarte, Victor -- Program Economist
Fofana, Mamadou -- GDO/IPM and Locust/grasshopper Assistance
Getson, Alan -- Deputy Director
Kibreab, Tadesse -- ADO, Farming Systems Research Project Officer
May, Chuck -- ADO, Agricultural Economist
McDonald, Wayne -- ADO, Natural Resources Management
McIntyre, Catherine -- Acting ADO
Poulton, Robin -- GDO, PVO Co-financing
Traore, Gaousso -- ADO, OHVN Credit and Transport Privatization
Tripper, Ellen -- GDO Consultant, Contract Forestry Law Revision

World Bank
Dejou, Chantal -- Economist, Ag Division, Sahelian Dept., Africa Region, Washington
Sow, Alassane -- Economist, Ag Division, Sahelian Dept., Africa Region, Washington

Peace Corps, Mali

Keita, Fafaren -- APCD, Education

Other Organizations
Diawara, Mahamadi -- Projet Gestion de Terroirs, CMDT/Sikasso
Haidara, Cherif -- BIAO loan officer
Ingoïba, Cheikh Amadou -- COMADIS (agricultural input distributor)
Lefay, Olivier -- Projet Gestion de Terroirs, CMDT/Sikasso
Sissoko, Cheick Oumar -- COMADIS (agricultural input distributor)
Traoré, Cheick Tidiane -- BNDA loan officer

NGOs and PVOs

CARE/Bamako
Steinberg, Doug -- Assistant Director; PVO Co-financing Project, NRMS-PVO Project

Villagers and/or Village Group and Village Association Members

Banamba Town
6 male farmers on large farm outside town
19 female members of a women's groupment villageois that do beef fattening (plus 1 male -- the husband of the president)

Digan I Village/OHVN South
Koné, Issa -- Animateur